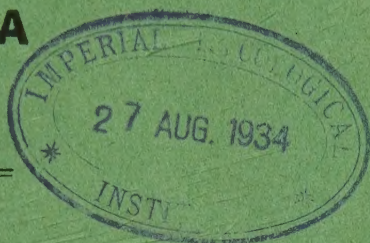


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RUBBER RESEARCH INSTITUTE

OF

MALAYA



ANNUAL REPORT 1933



Published by
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July 1934

Price \$1/-

THE RUBBER RESEARCH INSTITUTE of MALAYA

Members of the Board

JUNE, 1934

The Director of the Institute (Lieut.
COL. B. J. EATON, O.B.E.)

Chairman, *ex officio*

The Hon'ble the Financial Adviser,
F.M.S.

Financial Member appointed by the
High Commissioner under section
5 (i) (b) of Enactment no. 14 of
1934)

The Hon'ble the Director of Agri-
culture, S.S. & F.M.S.

Ex officio

CHE HAMZAH BIN ABDULLAH, M.C.S.

The Orang Kaya Kaya Stia Bijaya
di-Raja (CHE MOHAMED NOORDIN
BIN ABDUL SHUKOR)

} appointed by the High Commissioner
under section 5 (i) (d) of Enact-
ment no. 14 of 1934

Mr. A. P. CRANNA

Mr. CHOO KIA PENG, C.B.E.

Mr. J. S. FERGUSON

Mr. J. C. INNES, J.P.

The Hon'ble Mr. B. J. R. BARTON

} appointed by the High Commissioner
under section 5 (i) (e) of Enact-
ment no. 14 of 1934

The Permanent Committee

The Director of the Institute

Chairman, *ex officio*

The Hon'ble the Financial Adviser,
F.M.S.

Financial Member, *ex officio*

Mr. A. P. CRANNA

Mr. CHOO KIA PENG, C.B.E.

Mr. J. C. INNES, J.P.

} appointed by the High Commissioner
under section 13 (i) (c) of Enact-
ment no. 14 of 1934

RUBBER RESEARCH INSTITUTE OF MALAYA

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PUBLICATIONS.

Publications of the Rubber Research Institute are issued in the following forms :—

- (1) Planting Manuals appearing at irregular intervals at a price to be fixed for each number
- (2) Bulletins appearing occasionally at a price to be fixed for each number
- (3) Journal R.R.I. appearing at irregular intervals each year
- (4) Annual Reports

The following publications have been issued and copies can be obtained on application at the prices given against each :—

Bank commission should be added to outstation cheques

- | | | | |
|---|---|--|--------|
| (a) Planting Manuals | | | |
| No. 1, "Preparation of Plantation Rubber" | by B. J. Eaton ... | \$2.00 | |
| No. 2, "Budding of Hevea in Modern Plantation Practice" | by F. Summers ... | \$2.00 | |
| No. 3, "Plantation Sheet Rubber Manufacture" | by R. O. Bishop ... | \$2.00 | |
| No. 4, "Latex Preservation and Shipment" | by R. O. Bishop and R. G. Fullerton ... | \$2.00 | |
| No. 5, "The History and Description of clones of Hevea Brasiliensis" by C. E. T. Mann and C. C. T. Sharp | Illustrated by H. C. Chuan ... | \$2.00 | |
| | Additional leaflets free. Loose-leaf stiff cover in which leaflets are enclosed ... | \$1.00 | |
| (b) Journal of the R.R.I., Vol. 1, Nos. 1 and 2 | ... | \$1.00 | |
| Vol. 1, Nos. 3 and 4; Vol. 2, Nos. 1 to 4; Vol. 3, Nos. 1 to 3; Vol. 4 Nos. 1 and 2; Vol. 5 Nos. 1 and 2, each number | ... | \$0.50 | |
| (c) Annual Reports from 1928 | each ... | \$1.00 | |
| (d) Bulletin No. 1, | "Natural Coagulation of Hevea Latex" | by A. S. Corbet (out of print) ... | — |
| Bulletin No. 2, | "A Study of the Effect of Damp Storage on Raw Rubber" | by B. J. Eaton and R. G. Fullerton ... | \$1.00 |
| Bulletin No. 3, | "The Root Disease Problem on Old Rubber Areas in Malaya" | by A. Sharples and A. R. Sanderson ... | \$1.00 |
| Bulletin No. 4, | "Summary of Meteorological Records, Soils Division" | by W. B. Haines ... | \$1.00 |
| (e) Information Cards, dealing with various Phases of Rubber Estate Factory Practice and Defects in Raw Rubber | in Malaya ... | \$0.50 | |
| | outside Malaya ... | \$1.00 | |

REPORT OF THE BOARD

FOR THE

YEAR ENDED 31st DECEMBER, 1933

BOARD OF CONTROL

In October, 1932, the President of the Board, Dr. H. A. Tempany, tendered his resignation, but, at the request of the other members of the Board, he consented to continue in office until the end of the year, on the understanding that he did not wish to offer himself for re-election in 1933.

At the first meeting of the Board in 1933 Mr. E. N. T. Cummins was elected President and continued in office for the remainder of the year.

Mr. E. E. F. Pretty, Secretary to the High Commissioner for the Malay States, was on leave from the 14th April to the 24th November. During Mr. Pretty's absence Mr. W. D. Barron, acting Secretary to the High Commissioner, served on the Board.

The Hon'ble Mr. M. Rex, Treasurer, F.M.S., went on leave as from the 12th May, and in his absence the acting Treasurer, F.M.S., Mr. H. R. Joynt, served on the Board for the remainder of the year.

The three years' term of office of the Hon'ble Mr. H. B. Egmont Hake, an appointee of the Planters' Association of Malaya, expired on the 23rd February, 1933, and he retired from the Board.

Mr. R. S. Chantler was appointed to the Board by the Planters' Association of Malaya for a term of three years from the 24th February, 1933, *vice* Mr. Hake. Mr. Chantler subsequently went on home leave and resigned his seat as from the 25th May, 1933.

Mr. J. C. Innes was appointed by the Association, *vice* Mr. Chantler, for a term of three years from the 25th May, 1933.

In April Mr. R. M. E. Michaux, an appointee of the Malayan Estate Owners' Association, resigned from the Board in consequence of his absence from Malaya.

Mr. W. A. Stanton was appointed by the Malayan Estate Owners' Association to serve on the Board, *vice* Mr. Michaux, for a term of three years from the 24th April, 1933.

At the 31st December, 1933, the Board comprised:

The Director of Agriculture, S.S. & F.M.S., (Dr. H. A. Tempany, C.B.E., D.Sc., F.I.C., F.C.S.) appointed by Enactment

The Secretary to the High Commissioner for the Malay States (Mr. E. E. F. Pretty, M.C.S.), nominated by the High Commissioner to represent the States of Johore, Kedah, Kelantan, Trengganu and Perlis

The Treasurer, F.M.S. (the Hon'ble Mr. H. R. Joynt, M.C.S., M.F.C.), financial officer nominated by the High Commissioner for the Malay States

Che Hamzah bin Abdullah, M.C.S., nominated by the High Commissioner for the Malay States to represent small-holders

Mr. G. Wiseman, nominated by the High Commissioner for the Malay States to represent the planting industry of the Straits Settlements

Mr. C. B. Graburn, J.P.	} appointed by the Rubber Growers' Association
Mr. A. P. Cranna	

Mr. E. N. T. Cummins	} appointed by the Planters' Association of Malaya
Mr. J. C. Innes, J.P.	

Mr. K. Arumugam	} appointed by the Malayan Estate Owners' Association
Mr. W. A. Stanton	

BOARD AND COMMITTEE MEETINGS

During the year Board and Committee meetings as under were held:—

Board—ordinary meetings	...	5
Board—special meetings	...	3
Executive and Finance Committee	...	14
Research Committee	...	4
Rubber Roadways Committee	...	8
<i>Ad hoc</i> Committees	...	8
		42

COMMISSION OF ENQUIRY INTO THE AFFAIRS OF THE INSTITUTE

In November, 1932, the Board was informed by the F.M.S. Government that a request had been received from the Planters' Association of Malaya, the Malayan Estate Owners' Association and the Rubber Growers' Association for an independent investigation into the affairs of the Institute.

In the F.M.S. Government Gazette of the 26th May, 1933, there appeared a notification of the appointment by the High Commissioner of a Commission "to make a full enquiry into the constitution, administration and working of the Rubber Research Institute and to indicate any changes that may be desirable (a) in the constitution or governance and (b) in the orientation of the research work of the Institute."

The Commission was composed of Professor F. L. Engledow, M.A., B.Sc. (President), the Hon'ble Mr. T. S. Adams, M.C.S., and Mr. D. F. Topham, J.P. The President arrived from England about the 26th May, and the Report of the Commission was concluded on the 7th July, 1933. The Report, which was adopted by the Federal Council at its meeting on the 30th October, 1933, recommended *inter alia* the reconstitution of the Institute. It is understood that the necessary action to implement the Commission's recommendations will be taken.

REVENUE OF THE INSTITUTE

The cess imposed for the requirements of the Institute was, in January, 1933, 10 cents per pikul of rubber exported from the Federated Malay States and the States of Kedah, Kelantan and Trengganu, plus a contribution by the Straits Settlements Government at the rate of 10 cents a pikul of rubber calculated to have been produced in and exported from the Colony, plus a contribution of \$50,000 from the Government of Johore. As from the 1st February the cess was reduced to 8 cents per pikul and remained at that figure until the end of the year. Subsequently it was decided to make a further reduction, as from the 1st January, 1934, to 7 cents, which at the present rate of export of rubber, and with the contribution from Johore, is expected to produce sufficient revenue for the needs of the Institute; in the event, however, of a marked decrease in the volume of rubber exported it may become necessary to revise the cess.

At the formation of the Institute the Government of Johore agreed to contribute to the Institute a fixed annual sum of \$50,000 for a period of ten years, and this arrangement terminates at the end of 1934.

The amount received by the Institute for the year 1933 was:—

		Percentage of the total
from the Federated Malay States ...	\$343,782.02	66.67
„ Kedah ...	64,668.28	12.54
„ Kelantan ...	12,139.44	2.35
„ Trengganu ...	3,345.05	0.65
„ the Straits Settlements ...	41,707.34	8.09
„ Johore ...	50,000.00	9.70
	\$515,642.13	

The following table shows the quantity of rubber in tons estimated to have been exported from the F.M.S. and the U.M.S., and

to have been produced in and exported from the Straits Settlements, for each year from 1929 to 1933:

	F. M. S.	Kedah	Kelantan	Trengganu	Johore	Straits Settlements	Perlis	Total
1929 ...	261,353	39,298	8,042	2,212	89,296	50,061	291	450,553
1930 ...	250,122	38,303	7,375	1,998	90,639	45,590	266	434,293
1931 ...	244,149	40,290	6,593	1,860	90,778	29,993	196	413,859
1932 ...	235,892	39,044	5,171	1,817	86,686	30,399	159	399,168
1933 ...	250,550	47,121	9,290	2,456	96,941	42,009	323	448,690
	1,242,066	204,056	36,471	10,343	454,340	198,052	1,235	2,146,563
Percentages ...	57.86	9.50	1.70	0.48	21.17	9.23	0.06	

ACCOUNTS FOR THE YEAR 1933

Subjoined are the Income and Expenditure account for the year 1933 and the Balance Sheet as at the 31st December, 1933.

From the former it will be seen that the income from cess was \$515,642.13 for the year 1933, and \$8 307.69 short-paid by administrations in 1932: miscellaneous receipts were \$18,353.91, making a total of \$542,303.73. The total expenditure was \$408,898.81 on recurrent account and \$4,288.07 special expenditure.

From the balance sheet it will be observed that the total excess of assets over liabilities is shown as \$1,396,042.26 which is represented by

Land, Buildings and Furniture	...	\$ 477,256.96
Plant, Machinery and Apparatus	...	54,034.61
Experiment Station		448,333.62
Stocks		1,854.50
Sundry Debtors (including cess unpaid)	...	78,356.13
Investments		362,224.15
Cash		69,128.15
		<u>\$1,491,188.12</u>
Less Sundry Creditors		95,145.86
		<u>\$1,396,042.26</u>

The Board has had under consideration the question of laboratory and office accommodation. The present building is

leased from Government and was formerly a private residence; the lay-out is not suitable for research work, and space both inside and outside the building is insufficient. The Board is satisfied it is essential that new buildings should be erected as soon as possible on land which is now in possession of the Board, and for this purpose the Board has accumulated funds. There is now available sufficient cash to finance the erection of new laboratories and offices near Kuala Lumpur and a factory at the R.R.I. Experiment Station, Sungei Buloh.

So far as the new laboratories and offices are concerned, the Board feels that in consequence of the imminent appointment of a new Board it is not in a position to take immediate action, but provision for the expenditure has been made in the 1934 estimates, with a strong recommendation to the new Board that the work should be commenced at the earliest opportunity.

SMALL-HOLDERS ADVISORY SERVICE

The Commission of Enquiry recommended the provision of special and adequate advisory service for the owners of rubber small-holdings by the appointment of a staff of Asiatic officers with suitable qualifications, such officers to be appointed by the Director of the Rubber Research Institute in consultation with the Director of Agriculture and to work under the supervision of the Director of Agriculture.

As it appeared to the Board that there was no reason to delay such service, steps are being taken to implement the recommendation and the Director of Agriculture has formulated a scheme. Particulars of the scheme have been communicated to the Governments of the Federated Malay States, the Unfederated Malay States and the Straits Settlements for their approval. Pending such approval financial provision has been made in 1934 for the inauguration of a service.

In broad outline the scheme provides for an establishment of 22 Asiatic Instructors, and it is expected that the cadre will be completed in 1936.

Applicants must hold the diploma of the School of Agriculture, Malaya, or, in special cases, an approved equivalent.

On appointment the Instructors will be given a further period of training under the supervision of the Director of the Rubber Research Institute; they will then be allocated to districts throughout the Peninsula and will, for administrative purposes, be subject to the direction of the Field Officers of the Department of Agriculture.

The course of training under the Rubber Research Institute will embrace tapping systems, soil improvement, budding technique, diseases and pests prevention and treatment, the preparation and marketing of rubber (in collaboration with the Co-operative Societies Department), and methods of conveying information to small holders (in collaboration with the Department of Agriculture.)

NEW DIVISION OF THE INSTITUTE

During the year the organisation of the Institute was altered by the addition of a Technological and Advisory Division.

THE DIRECTOR OF THE INSTITUTE

The Director, Lt. Col. B. J. Eaton, returned from leave on the 18th February, 1933.

E. N. T. CUMMINS

President of the Board

Kuala Lumpur,
13th March, 1934

STATEMENT OF ACCOUNTS

FOR YEAR ENDED

31ST DECEMBER, 1933

THE RUBBER RESEARCH

INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE			₹	p.
To Experiment Station	...	...	33,647	91
„ Board and Committees (Fees and Expenses)	...	...	8,192	05
„ London Advisory Committee	...	...	13,480	01
„ Salaries and Allowances	...	...	181,008	31
„ Provident Fund	...	...	8,582	77
„ Staff Leave Pay and Passages	...	...	41,978	00
„ Rubber Roadways Research	...	...	5,138	54
„ Medical	...	...	2,469	51
„ Travelling	...	...	10,090	30
„ Office General Charges—(Printing, Stationery, Postage, Telephone, Audit, Legal)	...	...	5,034	93
„ Rents, Rates and Insurance	...	...	5,467	50
„ Laboratory General Charges	...	...	1,177	57
„ Upkeep Buildings (Offices and Residential Houses)	...	...	5,435	47
„ Upkeep Laboratory Grounds	...	...	814	58
„ Upkeep Furniture	...	...	560	52
„ Plant and Machinery (running expenses)	...	...	6,571	16
„ Lorry (running expenses)	...	...	2,148	94
„ Workshop	...	...	80	43
„ Laboratory Apparatus and Glassware	...	...	2,784	97
„ Laboratory Chemicals	...	...	2,148	50
„ Publications :				
issued by the Institute	...	4,794	88	
grant to the Department of Agriculture for vernacular publications	...	2,000	00	6,794 88
„ Library (New books and subscriptions to periodicals)	...	...	2,749	18
„ Exhibitions and Demonstrations	...	...	839	24
„ Film Propaganda	...	1,342	62	
„ Training of Agricultural Students	...	1,467	74	2,810 36
„ Experiments (Field and Factory)	...	...	12,854	89
„ Depreciation for year	...	...	40,966	44
„ Commission of Enquiry	...	...	5,671	85
			408,898	81
„ Balance Excess of Income over Expenditure for year carried down	...	...	125,097	23
			₹ 533,996	04
To Excess of all Income over Expenditure carried to Balance Sheet	...	...	133,404	92
			₹ 133,404	92

(Sgd.) H. S. BLACKLIN
Secretary

Kuala Lumpur, 27th January, 1934.

INSTITUTE OF MALAYA

FOR YEAR ENDED 31st DECEMBER, 1933

INCOME							S	c.
By Collections and Contributions by Administrations								
for the year							515,642	13
.. Interest on investments	...	...	...			10,640	67	
„ Miscellaneous receipts:--								
Sales of rubber and budwood	...	...	...	3,541	47			
Sales of publications	...	...	...	1,647	18			
House rentals	...	...	...	2,041	00			
General	...	...	...	483	59	7,713	24	

(Sgd.) E. N. T. CUMMINS
President

Kuala Lumpur,
12th February, 1934.

INSTITUTE OF MALAYA

AT 31st DECEMBER, 1933

ASSETS								
	\$	c.	Depreciation for year		\$	c.	\$	c.
LAND AND BUILDINGS :								
132 Ampang Road								
Land as at 1-1-33					10,755	00		
Ampang Villa as at 1-1-33	17,266	28	507	83	16,758	45		
132a Ampang Road								
Building as at 1-1-33 ...	39,247	81	1,154	34	38,093	47	65,606	92
Land behind Ampang Villa as per last Balance Sheet							5,029	35
5 Circular Road								
Land as at 1-1-33					17,147	08		
Old building as at 1-1-33	13,448	80	395	55	13,053	25		
Three Houses as at 1-1-33	71,030	79	2,089	14	68,941	65	99,141	98
163 Ampang Road								
Land as at 1-1-33					31,440	35		
Old Building as at 1-1-33	12,488	34	367	30	12,121	04		
Five Houses as at 1-1-33	83,718	36	2,462	30	81,256	06	124,817	45
184/8 Ampang Road								
Land as at 1-1-33					45,422	50		
Five Houses as at 1-1-33	76,097	36						
Less refund excess deposit	16	21						
	76,081	15	2,124	89	73,956	26	119,378	76
LABORATORY BUILDINGS :								
As at 1st January 1933 ...	34,401	53	11,467	18			22,934	35
PLANT AND MACHINERY :								
Electric Plant								
As at 1st January 1933 ...	3,074	47	768	62	2,305	85		
General Machinery								
As at 1st January 1933 ...	14,640	65	2,196	10	12,444	55	14,750	40
FURNITURE :								
Residential Houses								
As at 1st January 1933 ...	30,336	86	2,275	26	28,061	60		
Office								
As at 1st January 1933 ...	10,070	90	755	32	9,315	58		
Laboratory								
As at 1st January 1933 ...	2,120	76	159	06	1,961	70		
Store								
As at 1st January 1933 ...	182	14	13	66	168	48		
Library								
As at 1st January 1933 ...	908	96	68	17	840	79	40,348	15
LABORATORY EQUIPMENT & APPARATUS :								
As at 1st January 1933 ...	41,597	81						
Additions during year ...	4,154	45						
	45,752	26	8,319	56			37,432	70
MOTOR LORRY :								
As at 1st January 1933 ...	1,530	75	382	69			1,148	06
Carried forward			35,596	97			530,588	12

THE RUBBER RESEARCH
BALANCE SHEET AS

LIABILITIES—(*cont.*)

	\$	c.
Brought forward	1,491,188	12

Carried forward

1,491,188 12

INSTITUTE OF MALAYA

AT 31st DECEMBER, 1933.

ASSETS—(cont.)							
		Depreciation for year					
		£	s.	£	s.	£	s.
Brought forward				35,506	97		530,588 12
WORKSHOP EQUIPMENT:							
As at 1st January 1933		827	59	124	14		703 45
R.R.I. EXPERIMENT STATION:							
Development Expenditure							
as at 1st January 1933 ...		453,535	33				
Additions during year ...		133	62				
		453,668	95	5,335	33		448,333 62
Total Depreciation				840,966	44		
LIBRARY BOOKS & PERIODICALS:							
As at 1st January 1933 ...						1 00	
Add Purchases during year						2,230 21	
						2,231 21	
Less written off ...						2,230 21	1 00
STOCKS:							
Petrol and Oil:							
Laboratory ...		98	25				
Experiment Station ...		74	00			142 25	
Empty Drums:							
Laboratory ...		145	50				
Experiment Station ...		103	50			249 00	
Stationery ...						621 89	
Sundry Materials:							
Laboratory ...		143	39				
Experiment Station ...		696	97			840 36	1,853 50
SUNDRY DEPOSITS:							
for Water, Telephones, etc.							
Laboratory ...		240	00				
Experiment Station ...		26	00				260 00
SUNDRY DEBTORS:							
Administrations ...						70,420 69	
Staff ...						1,922 36	
Accrued interest ...						4,888 19	
General ...						783 33	
At Experiment Station ...						81 56	78,096 13
INVESTMENTS:							
F.M.S. Government 4½% Loan 1931/59						166,748 72	
Nominal value \$157,800/-							
3½% British War Loan, 1932/52							
Nominal value £17,000/-						145,475 43	312,224 15
FIXED DEPOSITS:							
Mercantile Bank						10,000 00	
Chartered Bank						40,000 00	50,000 00
Carried forward							1,422,059 97

THE RUBBER RESEARCH
BALANCE SHEET AS

LIABILITIES—(cont.)

	S	c.
Brought forward	1,491,188	12

S 1,491,188 12

I hereby certify that to the best of my knowledge and belief all
Kuala Lumpur,
5th February, 1934.

We have audited the above Balance Sheet and Income and Expend
ture and certify same to be correct according to the best of our informa
Institute.

Kuala Lumpur,
5th February, 1934.

INSTITUTE OF MALAYA

AT 31st DECEMBER, 1933

ASSETS—(cont.)

	\$	c.	\$	c.	\$	c.
Brought forward					1,422,059	97
CASH AT BANK AND IN HAND:						
London Advisory Committee for Rubber						
Research (Ceylon and Malaya) ...		...	1,271	39		
Chartered Bank, London ...		...	1,544	72		
Chartered Bank, Kuala Lumpur:						
Board's Account ...		144	78			
Rubber Roadways Committee ...		6,646	86			
Working Account ...		15,035	10			
Experiment Station ...		1,087	46	22,914	20	
Mercantile Bank Ltd., Kuala Lumpur:						
Board's Account ...		...	43,261	02		
Petty Cash:						
Laboratory ...		69	59			
Experiment Station ...		67	23	136	82	69,128 15

 \$ 1,491,188 12

Liabilities to 31st December 1933 have been brought into account.

(Sgd.) H. S. BLACKLIN
Secretary

iture Account with the books and vouchers of the Rubber Research Institution and explanations given to us and as shown by the books of the

(Sgd.) GIBSON, ANDERSON, BUTLER & CO.

Chartered Accountants
Auditors

ANNUAL REPORT

OF

THE DIRECTOR

Introduction

The year 1933 constitutes the seventh complete year of the Institute's activities.

Owing to the retrenchments effected in 1932 the staff has been considerably reduced and the Field Division has been abolished. Only one Field Officer now remains on the staff and this officer has been attached to the newly-created Technological and Advisory Division. The retrenchment of personnel has naturally thrown considerably more work on the members of the Research Divisions both in respect of correspondence and visits to estates.

As far as possible, economy in time and expense has been effected by arranging special tours to estates in certain States and outlying districts to include a number of estates from whom requests for advice necessitating visits have been received. Such tours have been arranged in Kedah, Kelantan, Trengganu and Johore and in the more distant parts of Malacca, Negri Sembilan and Perak.

Judging from the letters received from managers of estates, these tours have proved quite successful.

Staff

DIRECTOR

Mr. A. Sharples continued to act as Director until the return of the Director from service leave on the 18th February.

BOTANICAL DIVISION

Mr. H. Gunnery was transferred from the Pathological Division to the Botanical Division and the title of his appointment was changed to Botanist.

CHEMICAL DIVISION

Dr. Rhodes continued to act as Head of the Chemical Division until 1st May, 1933, when he was confirmed in the appointment as

a result of the appointment of Mr. R. O. Bishop as Head of the Technological and Advisory Division.

Mr. J. D. Hastings, Temporary Chemist, Rubber Roadways Investigations, proceeded on leave on the 20th May. He was offered and accepted an appointment as Chemist on the permanent staff in place of Dr. R. G. Fullerton and assumed duty on his return from leave on 17th November.

PATHOLOGICAL DIVISION

Mr. A. Sharples resumed duties as Head of the Pathological Division on ceasing to act as Director on the 18th February.

SOILS DIVISION

No changes occurred in the personnel of the Soils Division.

TECHNOLOGICAL & ADVISORY DIVISION

Mr. R. O. Bishop was appointed Head of the Division and assumed the duties of this appointment on his return from leave on the 25th September. Mr. A. Moore, the only remaining Field or Advisory Officer, was also attached to this Division after Mr. Bishop's arrival. During the previous part of the year he assisted other Research Divisions in dealing with advisory correspondence and visits and also carried out experimental work for the Chemical Division.

EXPERIMENT STATION

Mr. H. W. Foston continued in charge of the Station, and Mr. D. S. Gardner continued to serve as Visiting Agent.

OFFICE

Mr. H. S. Blacklin continued to serve as Secretary. No further changes occurred among the clerical staff.

LIBRARY

Miss McInerny remained in charge of the Library.

Advisory Work

Advisory work has been maintained, although as was anticipated, both on account of the financial situation and also as a result

of previous investigations and advice on certain problems, the number of enquiries relating to some problems have decreased.

Thus, as a result of the previous investigations carried out by the Institute in relation to estate factory practice, the number of enquiries for advice has decreased since the operation of the new types of line-ahead sheeting batteries is now more fully understood.

The number of enquiries relating to the application of fertilizers has decreased, principally on account of the financial situation, but partly owing to the fact that previous investigations have indicated that manuring of mature seedling rubber is not economic at present prices of raw rubber.

Interest however in the development of natural covers for the improvement of soil has increased.

Enquiries for information on economic systems of tapping have been numerous. Experiments now in progress will in due course throw considerably more light on this problem.

Enquiries in relation to budding have been maintained although there is no doubt that interest in this problem would have been considerably greater if the financial condition of the industry had been better.

During the year 5266 letters including 3434 enquiries on planting problems were received and 4173 letters and reports were despatched, excluding those dealing with publications.

Considerable correspondence was maintained with the London Advisory Committee for Rubber Research (Ceylon and Malaya) and the Rubber Growers' Association in connection with problems of consumption research.

Many planters have also visited the Institute and the Experiment Station for advice.

Various tours have been arranged by Divisional officers in order to visit estates in certain districts from which enquiries have been received relating to specific problems. In arranging these tours other estate managers in the district are informed usually through the local planting association, so that their estates can be included in the tour if they desire a visit.

The tours carried out during 1933 include the following:—

- (1) A tour in Kedah by Mr. R. P. N. Napper in connection with diseases.
- (2) A tour by Dr. J. L. Wiltshire in south and central Perak and tours by Mr. R. O. Bishop in Kedah and central Perak in connection with factory procedure.

- (3) Tours by Dr. W. B. Haines in Negri Sembilan (3), north, south and central Johore (2), Sitiawan and central Perak, and by Mr. C. G. Akhurst in Kedah, Lower Perak and Negri Sembilan in connection with soil problems.
- (4) A tour by Mr. C. E. T. Mann in central and south Johore in connection with budding and other botanical problems.
- (5) A tour by Mr. A. Moore in Kelantan and Trengganu in connection with various problems of estate practice.

These tours embraced visits to 143 estates.

In addition numerous visits have been paid to individual estates in various parts of the peninsula.

The principal enquiries received are shown in the following summary:—

Cover Crops, Natural Covers, Cultivation,	
Manuring and Replanting	... 270
Budding and Selection	... 312
Tapping Methods	... 295
Diseases and Pests	... 776
Latex Preservation and Concentration	... 639
Rubber Preparation, Coagulants, etc.	... 425
Factory Practice, Smoke Houses, Machinery,	... 176
New Uses, Modified Rubber and Manufacture	... 224

A detailed summary for each Division is published as an Appendix to this report.

SMALL HOLDERS' ADVISORY SERVICE

As a result of the Report of the Commission of Enquiry, steps have been taken to inaugurate a Small Holders' Rubber Advisory Service. Asiatic students from the School of Agriculture, Malaya at Serdang who have undergone the full course of training and have satisfactorily passed the prescribed examinations will be selected for appointment as Instructors.

It is anticipated that this service will be operating about the middle of 1934, when a number of students will be available to form a nucleus, although the proposed cadre will not be completed until 1936.

It should be possible to make a number of improvements in respect of rubber small holdings if the advice tendered by means of this service is adopted.

With the present staff and organization it is impossible to give any direct attention to the numerous small units of rubber scattered throughout Malaya, which constitute a very large area *in toto*.

LIAISON AND CO-OPERATION WITH OTHER MALAYAN INSTITUTIONS

The Director has continued to serve on the following Committees:—(a) The Advisory Committee of the Department of Agriculture, S.S. & F.M.S., (b) The Publicity Committee of the Department of Agriculture, S.S. and F.M.S., (c) The Agricultural Pests Advisory Committee of the Department of Agriculture, S.S. and F.M.S., (d) The Kuala Lumpur Garden (Department of Agriculture S.S. & F.M.S.) Committee, (e) The Advisory Committee of Agriculture, Malaya, (f) The Marketing and Propaganda Committee of the Co-operative Societies Department, S.S. and F.M.S.

LIAISON WITH OTHER INSTITUTIONS

Correspondence has been interchanged on a number of technical problems with (a) The Proefstation West Java, (b) The A.V.R.O.S. Proefstation, Sumatra and (c) The Rubber Research Scheme, Ceylon.

Owing to the temporary suspension of the activities of the Research Association of British Rubber Manufacturers for the greater part of the year it has not been possible to maintain correspondence with this Institution.

It is gratifying to note however that this Association has been re-organized and has again commenced to function.

CO-OPERATION WITH LONDON ADVISORY COMMITTEE LABORATORIES

The arrangements made at the beginning of 1932 for collaboration with the laboratories of the London Advisory Committee for Rubber Research (Ceylon and Malaya) have worked very satisfactorily and considerable exchange of correspondence has taken place weekly and frequently by air mail with the Secretary and the Superintendent of laboratories, both by means of official letters and reports and by personal letters between the Director and Head of the Chemical Division of the Institute and the Superintendent of the laboratories. Various samples of raw rubber have been sent for investigation, including samples prepared at the request of the Superintendent of the London laboratories and samples prepared on the initiation of the Head of the Chemical Division of the Institute.

Further reference to the various investigations in progress will be made in a later section of this report and in the report of the Chemical Division. The help and assistance rendered by Mr. Martin, Superintendent of the London laboratories is appreciated. Contact is also maintained with the work carried on in the London laboratories on behalf of the Rubber Research Scheme, Ceylon

and also with the work carried out directly in Ceylon by the exchange of reports between the three organizations. This serves to prevent any serious overlapping.

CO-OPERATION WITH THE RUBBER GROWERS' ASSOCIATION

Close contact has been maintained with the Technical Research and Development of New Uses Committee of the Rubber Growers' Association by means of correspondence. Requests for various samples of rubber prepared in a special manner for investigations being carried out under the control of this Committee have been met from time to time.

The detailed reports of the investigations in progress are received periodically and reference will be made later to those which are of interest, the results of which have already been published in the R.G.A. Bulletin or in other publications.

Considerable correspondence has also been exchanged on the proposed new specifications for latex which are being considered by the Rubber Trade Association, London, reference to which will be made later.

The value of this collaboration between the various organizations is realized by the scientific and technical officers concerned.

Soil Investigations

MANURING OF RUBBER

As during the previous year and chiefly on account of the greater intensity of the slump in rubber prices, interest either in fertilizer trials or in the general application of fertilizers on estates, in the case of "mature" seedling rubber giving low yields, has decreased.

Observations however are being continued on a few of these trials which are still being maintained. Certain trials initiated by fertilizer firms are also being continued and contact is maintained with these. As a general rule, however, it may be taken for granted that expenditure on fertilizers in the case of many of the present stands of deteriorated seedling rubber, in which both bark renewal and yields are bad, is not justified at present prices of rubber, but improvement, even although delayed, can be effected.

In such cases replanting with high yielding material, combined with the application of fertilizers from the date of replanting is the alternative and is likely to be an economic proposition.

In relation to replanting, observations on several experimental areas have already demonstrated the necessity for the use of ferti-

lizers to ensure satisfactory growth. Similar conclusions have been stated as a result of experimental trials in Netherlands India.

CULTIVATION UNDER NATURAL COVERS

It still appears necessary to offer some comments on "forestry methods" of cultivation, especially in relation to the misuse of this term.

In the first instance two aspects of the problem must be considered, although only one aspect has received consideration as an estate practice.

The essential forestry aspect, to which only brief reference need be made, is that concerned with the natural regeneration of Hevea by close planting in the first instance and the replacement of low yielding, diseased or other unsatisfactory trees by naturally regenerated seedlings. The value of such a method will need prolonged experiment and observation before any pronouncement can be made as to its value in planting practice. Secondly, modern methods of vegetative reproduction and seed selection for the establishment of high yielding planting material renders such a system even more problematical.

The other aspect of the problem to which considerable attention is being paid primarily concerns the soil and is a *soil problem*, not a *forestry problem*.

A Malayan authority on forestry in a communication to the writer states "The mere fact that the initiative was taken by a forester and that the principles involved are familiar to every recruit does not make them a prerogative of the forestry profession and it is in some respects a pity that the rubber forestry slogan was ever coined". A more satisfactory definition or designation would be "Cultivation under Natural Covers" as a means of regenerating soils which have become impoverished by previous erosion and loss of humus due to the practice of clean weeding or to a prolonged history of previous cultivation under other crops.

It may be emphasized here that the improvements which may be effected after a shorter or longer period, depending on the extent of deterioration, are due to the following factors:

- (a) reduction or prevention of soil loss by erosion
- (b) reduction in run-off of rainfall by improving the percolating capacity of the soil.
- (c) improvement of the water absorption capacity of the soil by the "forest litter" formed and its decay.

- (d) shading of the soil and maintenance of fertility in relation especially to biological activities by the building up of humus or the maintenance of the original humus, which on a bare soil is rapidly lost at the high soil temperature under clean weeded conditions.

To those who are interested in the scientific aspect of the problem, two Technical Communications issued recently by the Imperial Bureau of Soil Science, viz. No. 28/1933 "Soil Erosion" and No. 29/1934 "Soil, Vegetation and Climate" are of considerable value.

The following excerpts from these publications have an interesting bearing on the problem:

"At one time tree cover was regarded as confined to the interception of beating rain and this idea still holds in tropical countries where shade trees are grown with other crops. Gorsse showed in 1879 that the chief value was in the provision of forest litter which provides the chief protection against floods. The water capacity of such litter is about eight times that of soil. Lowdermilk suggests an additional function—prevention of silting of pore space by the washing down of finer soil fractions. Such silt below the surface of a bare soil acts as a filter and determines the rate of percolation. The retention of ground cover, litter and mulch offers the best solution of erosion, especially under highly developed systems of agriculture with permanent tree crops. In conjunction with rough terracing, bunding and contour planting a very complete degree of protection is assured.

The natural bias in favour of clean weeding is slowly breaking down and the present economic conditions have done much to discourage the practice."

Owing to the intensity of both rainfall distribution and evaporation of moisture there is a considerable difference between air climate and soil climate. This difference depends on the character of the vegetation and the protection of the soil. The soil temperature, especially in relation to fluctuations during the day and night, is influenced chiefly by the nature of the vegetation covering the soil. An essential difference between tropical and temperate conditions is that the living plant or association of living plants is the active soil-forming agent in the former, whereas in temperate climates the plant affects the soil mainly after death and during subsequent humification. In the tropics the dead plant residues decompose rapidly and do not persist long enough in sufficient quantity to affect soil development.

This involves another interesting and important difference, namely, that the generic nature of the vegetation covering the soil in tropical regions is of minor importance. Thus, in relation to the problem of the differentiation of harmful or harmless weeds in the development of natural covers on rubber estates, as we have endeavoured to point out, those which are described as harmful are so characterized on account of properties which are not related to their harmful effect on the soil, except in the case of plants which might grow into trees and possibly compete with the rubber trees.

The rapid turnover of plant nutrients is one of the most characteristic features in tropical rain forest soils such as in Malaya.

If the forest is destroyed, the chief source of plant nutrients is lost and the soil quickly deteriorates.

In the cultivation of natural covers we have a continuous cycle of growth and death and of leaf fall, and therefore the best conditions available for the growth of the main tree crop.

This constitutes the principal advantage of a mixed natural cover.

Two factors which have been raised as objections to natural covers are (a) the greater incidence and development of Mouldy Rot disease of the tapping panel (b) the greater possibility of certain human diseases caused by insects probably associated with rats living in the undergrowth.

Both of these drawbacks can be reduced to a considerable extent by keeping a certain space from each tree clear of covers and by proper control of the growth between the rows of trees. In any case the problem of natural covers and the incidence and development of Mouldy Rot disease, due to the more moist conditions under natural covers, must be realized.

A series of experiments has been initiated on a number of estates throughout the country in order to obtain more detailed information in relation to the effect of certain natural covers and their control under varying conditions of soil type and soil deterioration, caused either by previous clean-weeding practice or the previous cultivation of other crops before the establishment of rubber on such areas.

Changes have also been effected in the "secondary jungle" plot (Block 11) at the Institute Experiment Station, from which interesting and valuable results should be obtained in due course.

It is also proposed to establish new plots under natural covers.

The greater value of leguminous bush covers in comparison with "ground" covers is also indicated in other experimental plots at the Experiment Station.

Laboratory investigations have also been pursued in connection with several aspects of this problem of the cultivation of covers, to which more detailed reference is made in the report of the Soils Division.

WEED KILLERS

In the control of natural covers, and especially for the eradication of such plants as bracken and stagmoss, the use of weed killers has been proposed, since these have come into considerable favour during recent years in arable cultivation in various temperate countries. The economics of this practice however in countries such as Malaya, in which labour is comparatively cheap, have yet to be proved.

Botanical Investigations

In the previous Annual Report reference was made to the re-orientation of the research work of the Botanical Division as a result of the economic situation, particularly in respect of the study of physiological problems in relation to latex production and systems of tapping. Useful progress has already been made in this direction not only in the large-scale tapping experiment commenced under the direct control of the Institute on an area of mature seedling rubber leased from an estate, but also by collaboration with a number of estates.

In addition, tapping experiments have been continued on various clones under the direct control of the Botanical Division and also on estates which are collaborating in this work. Tapping experiments on budded rubber are likely to throw considerable light on these problems.

The Chemical Division is also collaborating in this work by investigations on the latex.

Interim reports on certain aspects of this work will be published during 1934. It may be noted here that the Commission of Enquiry appointed during the year to enquire into various aspects of the Institute's activities expressed their agreement with the programme of work outlined.

It appears necessary to emphasize however, in view of opinions held by those who have little knowledge of botanical research of this nature, that the problem of the physiology of latex production and the function of latex is not a problem likely to be solved to-day

or to-morrow, although tapping experiments combined with investigations of the effect of different tapping systems on the composition of the latex should enable us in due course to make recommendations which will prove valuable in estate practice.

This problem is also being studied by detailed anatomical investigations of the latex vessel system in different clones, together with similar investigations under different tapping systems.

Investigations in connection with problems of vegetative reproduction of high yielding planting material are also being continued.

IMPORTATION OF PLANTING MATERIAL

As a result both of the continued depression in the rubber planting industry during the year, and on account of the material now available in Malaya, the importation of budwood, selected seed and budded stumps has become almost negligible.

The figures provided by the Department of Agriculture, S. S. & F. M. S. are as follows:—

Budwood (Metres)	...	...	...	320
Budded stumps	...	...	...	160
Selected seed	...	...	...	Nil

The budwood and budded stumps were derived from material from Sumatra not hitherto used for commercial planting.

VEGETATIVE PROPAGATION

Investigations under this heading have included the following:—

- (i) Technique of Budding Operations
- (ii) After-Care of Young Buddings
- (iii) Vegetative Propagation of Stocks
- (iv) Studies of the Growth of Budded Trees
- (v) Influence of Density of Planting
- (vi) Growth and Development of Budded Trees in Mixed Plantings
- (vii) Relationship between Scion and Stock.

The results of these investigations may be briefly summarised as follows:—

- (i) A modified method of budding technique for large stocks, in which strips of old car tyres have been used instead of the bamboo strips used in the Garrot method, has given excellent results and is cheaper than the Garrot or the waxed bandage.

(ii) Investigations on the treatment of the pruning cuts at the union of scion and stock, in the case of large stocks have shown that a steep cut of not less than 45 degrees is the most satisfactory in relation to subsequent healing and rapid development of callus.

Black protective mixtures, such as asphalt-kerosene, especially if applied over the whole pruned surface, retard healing. The bad effect has been shown to be due to the high temperature developed as a result of heat absorption by the black surface. If black protective mixtures are used on the woody portion of the pruned surface, they should be again coated with a layer of white wash. Shading of the pruned surface without the application of any protective paint has been shown to accelerate the rate of callus growth and healing. The results of this investigation have been published in the Institute's Journal (Vol. 5. No. 2, 1934).

(iii) Experiments have been initiated with seedlings and bud-dings of a large number of different clones to ascertain the possibility of producing stocks of common origin suitable for budding. The experimental work also includes the etiolation method of stock production which has so far not proved successful.

Hitherto budding has been carried out on stocks selected primarily for vigour of growth.

(iv) Studies of the growth of various clones under uniform and different conditions have been continued on the Institute Experiment Station and on a number of estates on which the managers have kindly collaborated.

At the Institute Experiment Station, on which a Clone Trial Block was established for the study of nine well known clones, growth of all clones except BD.5 has been satisfactory and uniform. Clone BD. 5 does not appear to be very suitable for the soil on the flat area at the Experiment Station. This is probably due to its late branching habit and possibly similar slow development of lateral roots.

On a replanted area on an estate, on which five of the same clones together with another clone were established, the growth of all clones is definitely retarded.

Special treatment, including manuring, is probably necessary on most replanted areas in order to accelerate growth. Experiments have been commenced on this area to test the effect of artificial fertilizers and also digging in of the leguminous cover. The records of growth of various clones on a large number of estates have been made, in order to determine the age at which tapping can be carried out.

The figures published in the report of the Botanical Division (see Tables IV and V) show that certain clones are very sensitive to environment.

(v) A density-planting experiment of Clone A.V.R.O.S.50 at the Experiment Station shows that, at the age of three years, there is no significant difference in girth between the most closely planted (10ft x 10ft) and the most widely planted (30ft x 30ft), although at an earlier age the differences were more marked.

(vi) A plot of 22 acres under duo-clone planting has been established at the Experiment Station to include an old-established clone and a promising new clone.

This system of planting effects the establishment of a new clone as a mono-clone planting without delay since the trees of the "old-established" clone can be removed if the new clone is proved to be satisfactory or the old established clone can be left if the new clone is proved to be unsatisfactory. Eight new clones are being studied on this area.

(vii) A further study of the influence of stock vigour on the growth of scions confirms previous investigations. In young buddings the scion appears to become the dominant member. A much higher proportion of successes is however obtained on vigorous stocks than on those of moderate or slow growth. A plot has been established at the Experiment Station for the study of "high" buddings, and another plot of twin plants has been established from clonal seeds for the study of the effects of the influence of the scion on the yield of stocks.

A preliminary tapping test on scion and stocks has also commenced on an estate and will be continued.

The buddings of *Hevea brasiliensis* on stocks of *Hevea spruceana* in the isolated jungle plots attached to the Experiment Station are making good growth under semi-forest conditions of planting. These plots are also established for a study of the mutual relationship between scion and stock.

A study of the latex vessel systems in scion and stock has been continued and tapping experiments have also been carried out. The results obtained suggest that different scions may influence the properties of the stock, including a positive influence on the latex-producing properties.

THE PHYSIOLOGY OF THE RUBBER TREE IN RELATION TO LATEX PRODUCTION

Work under this heading has been extended to include the following investigations:

(i) Tapping Experiments on Mature Trees from Seeds

- (ii) Economic Tapping Systems in a specially controlled Experiment.
- (iii) Tapping Experiments on Estates with special Reference to Double-cut Systems.
- (iv) Tapping Experiments on Budded Trees.
- (v) The Dry Rubber Content of Latex under different Tapping Systems.
- (vi) Yield of Latex, Bark Consumption and Bark Renewal
- (vii) Economic Tapping Systems on Budded Trees.

On the mature area in the Experimental Plantation, Kuala Lumpur, leased from the Department of Agriculture a preliminary experiment with normal alternate-daily tapping has shown very large differences in yield, due probably to site (soil) and previous tapping history. The area is therefore unsuitable for detailed experimental work and can only be utilised for certain observations, such as the provision of material for anatomical study or for a study of the regeneration of soil under natural covers.

An extensive series of tapping experiments on an estate area leased by the Institute has been commenced and the records for the first year will shortly be available for publication.

The experiment embraces several periodic systems of tapping and resting and double-cut systems to include also various periods of tapping and resting.

The results for the first six months show a considerable drop of yield in all the systems except the double-cut fourth-daily and the one-cut alternate-daily systems without rest.

In double-cut tapping systems, carried out on mature trees on estates which have been in progress over a year, the loss in crop has averaged 17 per cent compared with normal alternate-daily tapping on a single cut. The yield per tapper has however increased by an average of about 43 per cent.

In two experiments on young trees the average yield is too low on the double-cut systems to be profitable at low prices.

Tapping experiments on budded trees have been continued on Pilmoor Estate. The results indicate the dangers of a too early selection of clones by initial tapping tests. The yield of latex, bark consumption and bark renewal continue to be satisfactory, while the dry rubber content of the latex is also high for these comparatively young trees. Another salient feature of these tapping tests is the relatively uniform yield of the budded trees, whether tapped at a high or low level.

Higher yields have also been obtained in a tapping experiment on budded trees for a single left to right cut, than for a right to left cut.

Single and double-cut tapping systems on budded trees show a more favourable return for the latter system than on seedling trees.

Interesting results have been obtained by carrying out different systems of tapping on groups of trees from one clone. A marked and progressive decrease in yield was noted as the tapping cut approached the division between virgin and renewed bark. Anatomical investigations are being conducted in order to ascertain any reason for this phenomenon.

Preliminary yields from tapping tests on the second generation of two clones have been very satisfactory. In relation to physiological studies generally, systematic anatomical investigations have been commenced and are described in the report of the Botanical Division. It is too early to make any definite pronouncement but suggestive differences which may prove of considerable value have been found.

The establishment of clones from new high-yielding Malayan estate mother trees has been completed in Block 15 at the Institute Experiment Station. In addition, fifty clones of historic interest from Sumatra and Java, together with clone A.V.R.O.S. 50 as a standard, have been planted in this Block.

Work on pollination and breeding has been limited to the completion of budding of new clones derived from seedlings obtained by artificial pollination between high-yielding clones.

Test-tapping has been commenced on some of the trees at the Experiment Station and the results are promising.

Similar test-tapping has been commenced on seedlings from high-yielding clones.

Further test-tapping of seedling trees has been carried out with the object of determining the value of particular methods in the thinning-out of seedling plantations and also to re-examine the hypothesis that good yielders remain good and poor yielders remain poor.

The coefficient of correlation between yields for three separate periods is very high.

A similar close agreement between short and long periods of tests in successive test-tappings is also shown. These tests will be continued in order to obtain a correlation with the yields when the trees are "mature" and in regular tapping.

A considerable amount of time has been spent in the identification and classification of the various natural covers occurring under "forestry" methods of cultivation, which have been received from estate managers.

The Head of the Botanical Division in his discussion of this subject emphasizes the opinion, which has already been expressed in the section entitled "Soil Investigations," as to the relative unimportance of such identification as compared with a general study of the habits or characters of the numerous plants found in the development of natural undergrowth.

Diseases and Pests

No general outbreak of disease has occurred during the year, although the leaf disease caused by the Mildew fungus (*Oidium Heveae*) was virulent on a number of estates in a few districts in which the climatic conditions were favourable to its development.

Mouldy Rot disease of the tapping panel continued to be troublesome on small-holdings, since it has not been possible to enforce rigid control of treatment on account of the economic situation.

Investigations on the two principal root diseases—*Fomes lignosus* and *Ganoderma pseudoferreum* have been continued on several estates and much valuable information on methods of treatment has been gained.

Further details of the principal diseases and pests and investigations in relation thereto are given below.

ROOT DISEASES

Investigations on the three common root diseases of the rubber tree—White Root Disease (*Fomes lignosus*) Red Root Disease (*Ganoderma pseudoferreum*) and Brown Root Disease (*Fomes noxius*)—have led to a new conception of the relationship and similarity in modes of attack of the causal organisms concerned.

This enables the question of the treatment of these root diseases to be considered as a single problem.

In view of the different conditions in the soil in respect of lateral root contact and centres of original infected jungle material, it will be realized that the eradication of these diseases in young and old areas is essentially a distinct problem in each case.

The most important aspect of the problem is that, if inspection and treatment is carried out satisfactorily on young areas, it is possible to eradicate all root disease completely at an economic cost. The treatment of these diseases in many old or mature areas, in which the lateral roots of the rubber trees are interlaced over large areas, presents another problem and each case will require treatment on its own merits, depending chiefly on the extent to which the diseases have spread throughout the area.

In view of the importance of this problem, which has received close attention by the Pathological Division during the last few years, the new conceptions are discussed at some length in the section dealing with root diseases in the report of the Pathological Division.

PANEL AND STEM DISEASES

(a) *Mouldy Rot (Cerastomella fimbriatum)*

Apart from small-holdings, in which natural undergrowth has been usually allowed to develop, the recent interest in the development and establishment of such growths on large estates, in order to improve soil conditions, has increased the incidence of Mouldy Rot on such areas, owing to the damper conditions which prevail and which favour the spread of this disease.

In districts known to be particularly susceptible to the disease greater control of the natural undergrowth is essential. In any case it is advisable to clean weed or to keep the cover very low to a distance of about four feet from the trees. Such control is also essential for tapping and inspection purposes.

In relation to the treatment of the disease with various approved fungicides, spraying is more economical and rather more efficient than painting, for eradication.

On small holdings, it is almost impossible to obtain complete eradication of the disease, so that control and reduction of bark damage is the primary objective. On this account and on account of the fact that sprayers are expensive and more likely to be damaged, application of fungicides by painting is still recommended.

Investigations on a number of proprietary fungicides have been continued and the "White List" now includes eight approved proprietary products.

Two satisfactory fungicides have also been prepared in the laboratory which would probably prove more economical than most of the proprietary fungicides at present in use, if their preparation were undertaken locally.

(b) *Marasmius Panel Disease*

Investigations indicate that a "White Fan Blight" caused by a species of *Marasmius* may, under certain conditions, be actively parasitic on the newly-tapped surface.

(c) *Pink Disease (Corticium Salmonicolor)*

Outbreaks of this disease continue to occur in inland districts during rainy periods. Regular inspection and treatment of trees is advisable in such districts during the rainy seasons.

(d) *Black Stripe and Patch Canker*

Cases of these diseases have occurred and have been dealt with, especially in South Kedah and coastal districts of Malaya.

No epidemic outbreaks however have occurred.

(e) *Brown Bast*

The incidence of Brown Bast has decreased considerably with the adoption of more conservative systems of tapping, although enquiries are still received as to methods of treatment. Scraping or stripping of the bark is not advised.

LIGHTNING DAMAGE

The damage caused by lightning on a fairly large number of estates is now being realised. Certain cases of die-back and of claret-coloured or patch canker of the collar of the trees have been definitely associated with previous lightning attack. If the symptoms are recognized early and measures are applied to deal with the damage, the loss of trees can be considerably reduced. One very severe localised attack at the Institute Experiment Station, in a closely planted area of Clone A.V.R.O.S. 50, caused the death of about sixty trees. In this case, the incidence of lightning attack was very marked.

An article on this subject was published in the Institute Journal (Vol. 5, No. 1)

LEAF DISEASES

(a) *Oidium Heveae*

The outbreak of *Oidium Heveae* leaf disease during the refo-
liation period after wintering was sudden and of short duration owing to the dry weather in certain districts which caused a rapid and severe wintering. Inland districts in Selangor and Perak, where the rainfall was greater, were practically free from the disease.

In the Port Dickson (Negri Sembilan) Malacca and Sitiawan (Perak) districts, the climatic conditions were favourable to the disease and resulted in an almost epidemic spread of the disease on a number of estates in these districts in March. In Johore, a few sporadic occurrences were reported, while in other parts of Malaya no bad outbreak occurred.

A communique was issued to the Malayan press early in February requesting all managers of estates to report outbreaks and to send specimens of leaves for diagnosis.

Arrangements were made by a number of estates to carry out sulphur-dusting treatment and a number of demonstrations were given.

No definite pronouncement can be made as to the effect of the disease on bark renewal or yield of latex, since attacks have not yet been sufficiently severe or recurrent.

A number of estates have arranged to purchase dusting machines and sulphur for treatment during 1934, if the conditions prove favourable to a virulent outbreak of the disease. This may be considered a wise insurance policy in spite of the expenditure involved.

A full report of the outbreak was published in the Institute Journal (Vol. 5. No. 1).

A number of specimens sent in for diagnosis were found to be attacked by a small spider and mites. Reference is made in a later section to the damage caused by these insects.

Arrangements were made to circulate a warning to all estates early in 1934.

(b) *Bird's Eye Spot Disease*

This disease, caused by the fungus *Helminthosporium Heveae*, has continued to give trouble on young trees, including buddings in nurseries. Sulphur-dusting by means of hand sprayers is recommended.

DISEASES OF BUDDED STUMPS

A number of cases of die-back of the pruned cut of the stock, which spread into the scion, were found to be due to the high heat absorption by the black asphalt-treated surface of the pruned stock. In Indo-China, where similar effects have been observed, lime washing of the pruned surface and of a small portion of the bark, above and below the union, has been recommended. If an asphalt-kerosene mixture is used, it should be applied only to the woody centre of the pruned surface and be covered with a white wash, since, if applied over the whole surface, it retards the growth of callus and consequent healing.

Under the section "Botanical Investigations," however, no treatment, other than partial shading of the pruned stock, is recommended in the case of large stocks.

A disease of the leading shoots associated with two fungi has also occurred on several estates.

INSECT AND ANIMAL DAMAGE

White Ants

Investigations have been continued on the treatment of white ants, which are still as serious a pest among young rubber clearings as in the early days of rubber planting.

A number of volatile toxic substances and toxic powders and liquids have been experimented with, including fumigants, contact and stomach poisons and explosive gases. Systematic inspection and treatment is the only satisfactory method of eradication of this pest. An article on these investigations is being prepared for publication in 1934 (see Institute Journal Vol. 5. No. 2):

Cockchafer Pest (Psilopholis grandis)

No further progress has been made in dealing with this pest on the two estates on which it has so far been found.

No extensive damage however can yet be reported, although the grubs effectively destroy all natural undergrowth by attacking the roots of the young plants.

Correspondence has been exchanged with the Department of Agriculture, Zanzibar, where a similar or related pest has been found to attack clove trees, and with the Minister of Agriculture, Queensland, where a related grub is a serious pest of sugar cane. In the case of sugar cane, digging and soil fumigation have been used to control the grub.

Nettle Caterpillar (Thosea sinensis)

Although no damage has been done by this pest, its presence constitutes a nuisance to the labour force, since the hairs of the caterpillar set up an intense irritation of the skin. The pest is usually found on estates under grass, which must be removed in order to effect control.

Spider

A small Attid spider has been found to cause leaf damage, which has been mistaken, in a number of cases, for *Oidium Heveae* leaf disease.

These spiders weave together a number of young leaves, producing a damp chamber, which induces the development of leaf spotting fungi, causing discolouration and death of the leaf tips. Mites and a leaf-eating weevil are also frequently associated with the spider, causing further damage.

Slugs and Mites

Slugs and mites have caused damage on young budded trees in several districts by denuding the young plants of their leaves.

Rat Damage

Several cases of rat damage, especially on young seedlings and buddings, have been reported. These occur invariably on areas under cover crop. The principal method of control recommended is the use of poison baits. Baits which have been prepared and used by the Department of Agriculture for the destruction of rats in padi fields have been found to be successful for dealing with attacks on rubber trees. Details of the composition and preparation of these baits are given in the report of the Pathological Division.

Chemical Investigations

Mention has been made previously of the satisfactory liaison which has been established with the laboratories of the London Advisory Committee for Rubber Research (Ceylon and Malaya). This collaboration also extends to the Technical Research and Development of New Uses Committee of the Rubber Growers' Association, London.

Samples of specially prepared rubber have been despatched to both of these organizations for investigations or to meet special requirements, and also to supplement tests carried out in our own laboratories.

As a result of the special visit paid to the United States of America by Mr. Bishop at the end of his leave, useful information has been obtained and contacts made with consumers and buyers of raw rubber and latex, which should prove of value in enabling us to advise producers re consumers' requirements. It is obvious that, especially in America, many consumers are not sufficiently in close contact with producers and are therefore liable to blame producers for various defects in the quality and the packing of raw rubber which would appear to be due largely to the subsequent handling of the raw product after it leaves the estate.

Most of the largest American factories have offices and buyers in Singapore, so that they should be able easily to maintain contact with estates.

It must however be borne in mind that quite a considerable proportion of re-milled rubber derived from small holdings both in Malaya and Netherlands India is shipped from the Singapore re-milling factories to America, while a very large number of the larger European-owned estates under various agencies ship their product direct to London. This problem of closer liaison between the consumer and the producer is essentially

a matter for those representing the commercial interests of the industry, although the Institute, as far as is possible, is prepared to assist any consumer in obtaining his requirements.

It is now realised that manufacturers' requirements vary considerably, according to the type of goods manufactured. At the same time, the producer will certainly not be prepared to meet any specific requirement, if the method of preparation involves any extra cost, unless he is able to obtain a premium to cover such extra cost. In any case, it is realized that further investigations are essential in order to ascertain the most satisfactory methods of preparation of raw rubber having certain desirable qualities such as "softness" or low water absorption capacity.

It has been found that the treatment of each single sheet of raw rubber with a lubricating powder before packing is very useful for the small manufacturer who lacks facilities for cutting the massed rubber which is received in the ordinary packing cases or bales.

Such treatment however involves extra time, labour and material, so that no producer is likely to carry out such treatment unless the consumer will compensate him for the extra cost.

LATEX CONSTITUENTS

It has not been possible to make much progress in the investigation of the various unknown non-carbonaceous constituents of latex. Attempts to find a suitable use for quebrachitol, isolated from latex serum, have not proved successful. A supply of this product however has been maintained to meet applications from investigators.

It is realized that the essential value of such investigations is concerned with the influence of these constituents on the quality of the rubber.

LATEX PRESERVATION AND CONCENTRATION

Interest is not only being maintained but is increasing in relation to the use of latex, particularly for applications outside those of the rubber manufacturing industry. The most important developments are probably the manufacture of spongy rubber for upholstery, the coating of wood and hair for a cheaper type of upholstery, and the manufacture of cylindrical rubber thread for the textile industry. No satisfactory substitute for ammonia as a preservative has been discovered, although a number of proprietary products have been recommended. Three methods of concentration, viz. by (a) centrifuging (b) squeezing and (c) evap-

ration in the presence of suitable protective colloids or stabilisers are now being utilised commercially.

With reference to the statement contained on page 30 of the Annual Report, 1932 attention has been called to the fact that the Dunlop centrifugal concentrate is marketed both as "Dunlop 60 per cent latex" and as Jatex. The term Jatex is applied as a shipping mark by the agents for the sale of this concentrate in Europe. Jatex constitutes only a small proportion of the total output of Dunlop centrifuged concentrate.

In a note in the India Rubber Journal, Vol. LXXXVI, No. 13, p. 6 (September 23rd 1933) attention is also directed to the fact that ammonia is no longer added to Revertex when this is exported. In the Annual Report for 1932, p. 30 it was stated that ammonia was used as a preservative.

Investigations on all of these methods have been carried out at the Institute.

Two suitable creaming agents have been successfully used and various experiments conducted to produce a cream of about 58—60 per cent dry rubber content which is not subject to after-creaming.

Concentration in an experimental centrifuge has also been carried out and arrangements made for the purchase of a new machine for further experimental work.

Arrangements were also made with the Superintendent of Laboratories, London Advisory Committee, and Mr. Bishop while on leave to carry out concentration experiments by the use of a spray plant. These experiments proved successful. Arrangements have since been made by the Rubber Growers' Association in collaboration with the London Advisory Committee, and also by a Malayan estate, to carry out further experiments on similar lines.

At present the maximum concentration of centrifuged and concentrated latex is about 60 per cent dry rubber whereas, in the evaporation process, which is almost certainly more costly, a concentration of about 70 per cent is obtained.

It is possible that a combination of the various processes in order to obtain a latex of high concentration at a lower cost may be desirable.

INVESTIGATIONS ON LATEX

Apart from the problem of the separation and identification of the non-caoutchouc constituents of latex, certain physical characteristics of latex are of considerable importance in relation to various uses. In this connection, the viscosity of the latex and its stability are of great importance, while colour is of importance for other applications. A proposal has been placed before the Rubber Trade Association, London, for the establishment of a

specification. We have however pointed out the necessity for further investigations before the proposed specification can be accepted and our recent investigations have confirmed the correctness of this attitude.

As a result a conference of chemists, to include the Superintendent of Laboratories of the London Advisory Committee, is being arranged to discuss the tests proposed in connection with the specification.

It is agreed that a specification is desirable in order to exclude from the market undesirable latex and to build up the latex market on sound lines. The necessity for establishing a suitable standard is indicated by the number of complaints concerning coloured and unstable latex which have already appeared on the market. It is however essential to determine the causes of various defects before a remedy can be applied and also to ascertain the value of some of the proposed tests and the conditions under which these tests must be carried out.

A lot of valuable data has already been accumulated by the Chemical Division in relation to viscosity and dry rubber content and specific gravity of latex.

CLONE RUBBER AND LATEX

Investigations on clone rubber and latex are being carried out by the Chemical Division and will be extended as material becomes available.

In relation to clones already examined, greater differences in latex due to seasonal causes has been shown than between the latex from different clones. Investigation of the potash, phosphate and nitrogen content of latex of budded rubber under different tapping systems and from high and low cuts has been carried out; a bulletin containing the results of this preliminary work is in press.

This work is also correlated with the investigations on tapping systems carried out by the Botanical Division in relation to the problem of the physiology of latex production.

COAGULANTS OF LATEX

Considerable interest has been evinced in the use of sulphuric acid as a substitute for formic or acetic acid in the coagulation of latex.

The India Rubber Manufacturers' Association, Great Britain, has also approached the London Advisory Committee on the subject, since a number of manufacturers fear the possible results of any changes in methods of coagulation of latex or treatment of the raw material.

The technical evidence available indicates that sulphuric acid, when used in minimum amount, is not deleterious. Excessive amounts are not likely to be used, since a sheet rubber of good appearance can only be prepared by using the minimum amount necessary for coagulation.

At the same time this Institute has to draw attention to manufacturers' requirements or prejudices and therefore to indicate to all producers the disadvantages of using this acid, in spite of the economy effected.

One proprietary coagulant—First Para-Maker—has been investigated and found to be unsatisfactory and uneconomical.

MOULD PREVENTATIVES

The use of para-nitro-phenol as a mould preventative in the preparation of smoked sheet has been considerably reduced and only a few estates still use this substance. Attention has been drawn by the India Rubber Manufacturers' Association, Great Britain, to the use of this substance in pale crepe. The rubber so treated, when used for certain purposes, produces a yellow stain or discolouration which is undesirable. It has been pointed out however that para nitro-phenol is not used on estates in Malaya for the preparation of pale crepe rubber.

Several proprietary fungicides have been examined as possible substitutes for para-nitro-phenol, but none of these has proved as satisfactory.

MODIFIED RUBBER

Investigations have been carried out in the London Advisory Committee Laboratories, and also by the Technical Research and Development of New Uses Committee of the Rubber Growers' Association, London, on the preparation of rubber having specific properties such as softness or high plasticity, low water absorption capacity and absence of odour. Investigations on powdered or crumb rubber have also been continued in the London Advisory Committee Laboratories.

Apart from meeting the requests of these organisations for samples prepared by certain methods, additional samples which have been prepared by methods suggested by us, have been despatched for investigation.

No suitable preliminary method of treating latex or raw rubber on the estate in order to produce a more plastic product has yet been discovered. Investigations are however being continued.

The investigations in relation to (a) the preparation of raw rubber suitable for the production of an odourless manufactured

rubber and (b) raw rubber having a low water absorption capacity more suitable for insulation in the electrical industries, are still in progress.

SHEET RUBBER PREPARATION

Interest is maintained in the recommendations made by the Institute for the installation of line-ahead sheeting batteries combined with satisfactory synchronization of speeds of the various machines. All new installations in estate factories are now made on this principle. It is of interest to record that all of the leading manufacturers of estate factory machinery have also adopted the principle and a number of suitable batteries are now in existence. Useful improvements have also been effected by two estate managers who have taken a keen interest in the problem.

Air-dried sheet of excellent appearance is being prepared on several estates for special buyers. This type of rubber has however not found general favour on the market as a substitute for smoked sheet. Investigations are proceeding in relation to the quality of air-dried sheet compared with smoked sheet, especially in relation to its plasticity.

Combined drying and smoking methods have been considerably improved and many estates now prepare a satisfactory smoked sheet (as for as appearance goes) in 5-6 days.

Investigations have been commenced in the Institute for the separate control of the drying and smoking processes in order to reduce the period of drying and to effect economy in fuel consumption.

PACKING

During the year, several consignments of smoked sheet rubber packed in bales of special material such as mengkwang palm matting and hessian have been despatched to London for report. In addition, at the request of the London Advisory Committee, bales containing sheet rubber in which each sheet has been specially treated on the surface with certain lubricating powders, with the object of reducing or preventing massing, have been prepared and shipped to London.

One difficulty in this connection is that we cannot be certain that such bales will be placed under other goods in the ship's hold, so that the bales are subjected to prolonged pressure during the voyage. These investigations are being continued and also include shipments in special paper sacks.

In relation to the problem of the separate treatment of each sheet with a lubricating powder, it must be pointed out that no

producer will adopt this method if the cost, when combined with the cost of a cheaper packing material than the wooden case, is greater than present methods of packing, unless the consumer is prepared to pay a premium to cover such extra cost.

The principal value of the use of lubricating powders in the treatment of each sheet is to enable the small manufacturers, who lack facilities for cutting the massed product, to separate the sheets in the bales or cases.

CRUMB RUBBER

Investigations on the preparation of crumb rubber have been continued in the London Advisory Committee laboratories and several consignments of rubber suitable for crumbing have been prepared by the Chemical Division and despatched to these laboratories.

It may be of interest to record also that two other methods of producing a crumb or powdered rubber have been developed in Holland.

To date however, as far as we are aware, this type of rubber has not found any definite commercial application.

RUBBER FLOORING

At the request of the Technical Research and Development of New Uses Committee of the Rubber Growers' Association, London, a series of small areas of various types of rubber flooring, from a number of manufacturers, have been laid at the ends of coaches on the F.M.S. Railways. This Institute is collaborating in these trials, on which periodic reports are made.

RUBBER ROADWAYS

The investigations in Malaya on rubber roadways have been in abeyance since the Rubber Roadways Chemist proceeded on leave in May 1933.

As a result of the recommendation of the Commission of Enquiry appointed to enquire into the affairs of the Institute, the question of the continuation of this work and collaboration with the London Advisory Committee awaits the report of that Committee as to future procedure.

The investigations however had reached a stage at which it was possible to carry out a commercial trial of the latex-cum-cement product developed in the Institute laboratories and this trial was laid down on the Kuala Lumpur—Port Swettenham Road in April—May 1933. Later, in July—August, trials of two

other products, viz. the rubber carpet or sheeting developed by Messrs. Kendall & Graham and the Parry-Davis-Cowling latex mixture, were made in Kuala Lumpur.

In addition, three cattle stalls in the Central Experiment Station, Serdang, were, at the request of the Director of Agriculture, S.S. & F.M.S., laid with our mixture.

Although we are not satisfied with the product developed in our laboratories it can be stated that it is probably the best of its kind and shows promise of the possibility of development of a satisfactory material for the purpose.

For interior purposes, such as for cattle and horse stalls, railway platforms and pavements the material should prove very satisfactory.

The Kendall-Graham rubber carpet is standing up well to tropical conditions. Unfortunately the traffic conditions to which it is subjected are not sufficient to enable us to make any statement in relation to anchorage, which is an important problem.

No further developments in relation to the application of rubber or latex mixtures to roadways in Great Britain or elsewhere during the last year are on record.

RECLAIM RUBBER

Reference might be made here to an investigation on Reclaim rubber carried out in the London Advisory Committee laboratories. The results of this investigation were published in the Bulletin of the Rubber Growers' Association in May 1933. The results indicate that reclaim does not possess all the advantages claimed for this material when used as a substitute for raw rubber, and that its use in some directions is dictated principally as a matter of economy. It is of interest to note in this connection that the percentage of reclaimed rubber to raw rubber used in America during 1933, fell to approximately 20 per cent, whereas, a few years previously, when raw rubber was at a high price, the proportion rose to as high as 50 per cent.

Experiment Station

The total area of the Experiment Station remains as at the end of 1932, viz, 2096 acres. Negotiations with the Selangor Government and the Forestry Department, F.M.S. & S.S. are in progress for an exchange of the present reserve area for a smaller area on the south-west boundary of the present planted area on

which the soil is more typical of inland rubber areas in Malaya than the greater portion of the present planted area.

Although the exchange was not completed at the end of the year, it is understood that it will be approved. The planted area at the end of the year is 811 $\frac{3}{4}$ acres, exclusive of two isolated jungle blocks of 5 acres each in the Forestry Reserve, which are not included in the alienated area, but which are held on lease by permits from the Forestry Department F.M.S. & S.S.

PLANTING

A new factory site has been selected at the northern end of the building site (Block I) and the original site selected will be planted shortly.

Another small area of about 3 acres in the south-eastern side of the building site is also being prepared for planting.

An area of 3 acres (Block 20 A) originally planted 30 ft. $\times$ 30 ft. was replanted at 15 ft. $\times$ 15 ft. with stumps from seeds of proved clones from isolated seed gardens.

An area of 2 acres (Block 9 A) reserved for investigations by the Pathological Division was also prepared for planting with seedlings from clone A.V.R.O.S. 157.

The nursery site of about 6 acres in Block 25 was planted with seedling stumps from clonal seed.

No new clearing in the reserve area was carried out during the year but the Board approved the planting of a further 60 acres in the new reserve during 1934. This will be planted with clonal seed and natural undergrowth will be maintained under different methods of control.

CULTIVATION EXPERIMENTS AND RECORDS

Manurial, cultivation and cover crop treatments and records of growth were maintained on various blocks on which observations are being kept.

A portion of Block 11, developed under natural undergrowth since the time of planting, was cleared in order to ascertain the effect on growth, since definite retardation of growth of the rubber trees is shown both in the uncontrolled area and in the area slashed twice yearly. The cleared area has shown a very marked development since the undergrowth was removed in February.

DISEASES AND PESTS

Systematic treatment of the two principal root diseases—*Fomes lignosus* and *Ganoderma pseudoferreum* has been continued during the year.

Experimental treatments for the control and eradication of white ants have also been carried out.

BUDGRAFTING EXPERIMENTS

A new method of budding technique for large stocks, using old motor tyres, has been tried and found to be very successful and economical.

Records of growth on the Clone Trial Plot (Block 5) show no marked difference between the various clones, except in the case of Clone B.D.5 which is very backward.

Further details of investigations at the Experiment Station are included in Divisional Reports and in the report of the manager.

FACTORY

The Board has allocated a sum for a factory and machinery, drying and smoke houses etc., which will be constructed according to the most modern ideas.

Conferences and Exhibitions

Several members of the staff contributed papers at the Annual Conference of the Incorporated Society of Planters, Malaya. These are included in the section under "Lectures."

The Institute staged exhibits at the Annual Exhibition of the Malayan Agri-Horticultural Association. These exhibits illustrated especially, (a) the principal root diseases of the rubber tree, comparing their similarities and methods of treatment (b) *Oidium Heveae* leaf disease, including a number of sulphur dusting machines and methods of treatment (c) articles manufactured from latex and rubber showing especially new applications of latex.

Lectures

The following lectures were given by members of the staff.

Subject	Venues	Lecturer
The Problem of Economic Yields from Modern Rubber Plantations	I.S.P. Annual Conference at Taiping	C. E. T. Mann

<i>Subject</i>	<i>Venues</i>	<i>Lecturer</i>
New Uses and Consumption of Rubber	do	J. L. Wiltshire
<i>Oidium Heveae</i> and its Control	do	F. Beeley
Soil Problems in Relation to Replanting	I. S. P. Taiping Branch	W. B. Haines
Recent Researches in finding New Uses for Rubber with particular Reference to Rubber Roadways	do	B. J. Eaton
Industrial Uses of Latex	I.S.P. Tampin-Bahau Branch	E. Rhodes
Some Reflections on the Rubber Industry and recent Advances in Manufacture	I. S. P. Kajang Branch	B. J. Eaton
Sulphur Dusting in the Control of <i>Oidium Heveae</i>	I.S.P. Nilai—Labu Branch	A. Moore
Preserved Latex — Its Preparation and Uses	I.S.P. Kelantan	A. Moore
Scientific Management	I.S.P. Council Meeting	B. J. Eaton
Natural Covers	District Planters at Sitiawan	W. B. Haines
Yields of Modern Rubber Plantations	Central Perak Planters' Association	C. E. T. Mann
Tapping Systems	Malacca Planters' Association	C. E. T. Mann
Root Diseases of the Rubber Tree	do	R. P. N. Napper
Natural Covers	Johore Planters' Association	W. B. Haines
Forestry Methods	Kedah Planters' Association, South Kedah Branch	C. G. Akhurst

Forestry Methods	Kedah Planters' Association, Central Branch	C. G. Akhurst
Natural Growths in Reference to Soil Conditions	Meeting of Managers of Sime Darby & Co. Malacca	W. B. Haines
The Rubber Industry in America	Rotary Club, Kuala Lumpur	R. O. Bishop

A paper entitled "Note on the Bearing of certain Meteorological Observations on Agricultural Problems in Malaya" was contributed by Dr. Haines to the Fifth Pacific Science Congress.

Publications and Library

The publications issued during the year include one number of the Journal (Vol. 5, No. 1), the Annual Report for 1932, and Planting Manual No. 5, entitled "The History and Description of Clones of *Hevea brasiliensis*". In the original issue of Manual No. 5 records of eight clones developed in Netherlands India and six clones developed in Malaya are included. These records refer to the oldest and best known clones which have been planted on a commercial scale in Malaya. The Manual is issued in loose leaf form so that records of other clones can be added. Records of six additional clones were ready for press at the end of the year and have since been added.

The Information Cards dealing with various aspects of estate practice and defects in raw rubber have been revised in a new form.

As a result of the completion of certain investigations it is anticipated that our publications will increase considerably during 1934.

A card index of all important articles concerning rubber and other information in various technical journals received in the Library, which are likely to be of value to the various Divisions of the Institute, has been maintained.

Translations of several articles from the Dutch have also been made.

Visits

A large number of planters visited both the Institute and the Experiment Station during the year.

A conducted tour of the Senior Students of the School of Agriculture, Malaya, was made both to the Institute and Experiment Station. The Vice-Principal of the School accompanied the students on these visits.

The members of the Malayan Branch of the Institute of Chemistry of Great Britain and Ireland visited the Institute during their Annual Meeting and Conference.

Special visitors include the following:—H. E. the High Commissioner, F.M.S., Sir Cecil Clementi G.C.M.G., Dr. H. N. Whitford (Rubber Manufacturers' Association of America) Mr. C. T. Wales (Director, Planters' Stores & Agency) Prof. F. L. Engledow M.A. B.Sc., (Draper's Professor of Agriculture, Cambridge University) Mr. F. D. Ascoli, C.I.E. (Managing Director, Dunlop Rubber Plantations Ltd.) Messrs. H. N. Blommendaal and F. Schmöle (A.V.R.O.S. Proefstation, Sumatra) Mr. G. H. Masefield (R.G.A. Council, London) Dr. E. M. McColm (Chemist, H.A.P.M. Sumatra) Right Revd. B. C. Roberts (Bishop of Singapore) Dr. P. J. S. Cramer (Holland) Col. J. Shelton Agar, D.S.O. (Ceylon) Mr. J. M. Martin (Colonial Office, London) Hon. Mr. Sturrock (Director of Public Works, S.S. and Adviser Public Works, F.M.S.) Lt. Col. G. P. Pollitt, D.S.O., M.C. (Imperial Chemical Industries, London) Mr. M. Chollet (Saigon) Mr. J. J. Blandin (Goodyear Rubber Co., U.S.A.) Mr. J. B. Ingle (Goodyear Rubber Plantations, Sumatra) Mr. J. W. G. Birnie (Saigon) Prof. Shibaya (Imperial University, Formosa) Dr. J. R. Weir (Agricultural Adviser, Ford Plantations, S. America) Mr. J. B. Barlow (Barlow & Co., London) Dr. G. M. Kraay (Chemist, Proefstation, West Java) Mr. E. A. Murphy (Chemist, Dunlop Rubber Co., Birmingham)

General

Acknowledgment is gratefully made to numerous managers of estates who have co-operated with us in various directions during the year. Such co-operation is of great value in enabling us to compare methods of treatment or procedure under varying conditions.

Acknowledgment is also made of the loyal co-operation of all members of the Staff.

The Annual Report of the London Advisory Committee for Rubber Research (Ceylon and Malaya) together with an Appendix, containing the Report of the Superintendent of Laboratories, are included in this Annual Report. The Appendix in particular indicates the more important problems which have been dealt with in the laboratories of the London Advisory Committee.

B. J. EATON
Director

APPENDIX

SOILS DIVISION

Analysis of Correspondence

Subject				Letters received	Letters despatched
Cultivation—General Enquiries ...				10	12
—Forestry Methods ...				42	51
—Experiments ...				72	85
Cover Crops and natural Covers :					
—General Enquiries ...				103	114
—Manuring ...				6	6
—Eradication by Weed-killers				36	40
—Seeds ...				19	25
Manuring ...				73	45
Soil Conservation ...				5	6
Drainage and Irrigation ...				3	3
Replanting ...				42	44
Visits ...				70	96
Fertilizers ...				13	12
Soil Samples ...				20	28
Miscellaneous ...				52	80
Total ...				565	647

BOTANICAL DIVISION
Analysis of Correspondence

Subject.		Letters Received	Letters despatched
I. Budding.	General. Advice on choice		
„	of Clones. Clone Records ...	215	242
„	Training of Conductors and		
„	Pupils from Estates, etc. ...	8	8
„	Field Experiments (Estate		
„	Trials)	10	10
„	Growth of Budded Trees ...	16	10
„	Purchases and Exchanges		
„	of Budwood	10	13
		259	283
II. Tapping.	Estate Enquiries. General	111	117
„	Estate Experiments. General		
„		46	44
„	Estate Enquiries (Tapping		
„	of Budded Trees) ...	8	8
„	Estate Experiments (Tap-		
„	ping of Budded Trees) ...	92	91
„	Test Tapping of Seed-		
„	lings	6	8
„	Tapping Systems. D.R.C.		
„	and Yields	26	27
		289	295
III. Selection.	Individual Mother Trees;		
„	selection on Estates ...	16	27
„	Seed Selection ...	3	3
„	Latex Vessel and Bark		
„	Examinations	1	1
„	Isolation Gardens ...	17	11
„	Earliest Trees & History ...	3	3
„	Seed Germination ...	3	2
„	Requests for Seeds ...	2	2
„	Seeds for Experimental		
„	Purposes	9	11
		54	60

Subjects.					Letters received	Letters despatched
IV.	General.	Planting Enquiries	...			
		Information on planting				
		Operations	...	...	11	15
	"	Cover Plants	...	...	54	68
	"	Catch Crops	...	...	3	3
	"	Thinning	...	...	1	1
	"	Pollination	...	...	1	1
					70	88
V.	Apparatus	...	...	...	3	4
VI.	Miscellaneous	...	...	...	23	29
Total					698	759

PATHOLOGICAL DIVISION

Analysis of Correspondence

			Letters received	Letters despatched
Root Disease	...	...	88	116
Stem and Bark Disease (Fungal)	...	...	82	93
Leaf Disease (Fungal)	...	...	149	167
Diseases and Pest Control	...	...	3	5
Fungicides and Insecticides	...	...	53	59
Floods	...	...	2	2
Injury by external Agents	...	...	13	17
Insect Pests	...	...	44	52
Brown Bast	...	...	15	20
Spraying and Dusting Equipments	...	...	7	9
Pathology of Buddings	...	...	46	65
Diseases—general Treatments	...	...	53	61
Replanting	...	...	6	7
Lightning injury	...	...	8	16
White ant Treatment	...	...	20	33
Sulphur dusting	...	...	31	56
Miscellaneous	...	...	40	55
Total	...	...	662	833

Samples Examined

Budded stumps	...	...	22
Plants and Shoots	...	...	7
Leaves	...	...	35
Branches	...	...	4
Bark	...	...	13
Roots	...	...	15
Insects	...	...	9
Miscellaneous	...	...	13
Total	...	...	118

Total Number of Visits	...	...	197
Total Number of Interviews	...	...	54

CHEMICAL DIVISION

Analysis of Correspondence.

Subject	Letters received	Percent- age of Total	Letters des- patched
Latex	25	1.72	41
Latex Preservation	341	23.53	400
Latex Concentration	147	10.14	165
Latex—Instruments for determining			
D.R.C.	113	7.80	150
Anti-coagulants of Latex	16	1.10	19
Anti-oxidants of Latex	6	0.41	5
Rubber Preparation (General)	59	4.07	76
Coagulants	60	4.14	73
Coagulating Tanks and Pans	15	1.04	16
Smoked Sheet	78	5.38	86
Smoke-Houses	54	3.73	65
Air-dried Sheet	13	0.90	18
Crepe Rubber	42	2.90	41
Crepe Rubber—Lower Grades	4	0.28	4
Sole Crepe	44	3.04	57
Raw Rubber Powder	1	0.07	6
Water Samples	13	0.90	20
Machinery for Rubber Manufacture	61	4.21	73
Vulcanisation of Rubber	69	4.76	93
Vulcanising Machinery & Apparatus	1	0.07	3
Accelerators for Vulcanisation	29	2.00	36
Rubber Fillers	1	0.07	1
Rubber Softening Agents	9	0.62	17
New Uses of Rubber	54	3.73	67
Rubber Substitutes	1	0.07	1
Rubber Paving for Road Surfacing	54	3.73	71
Rubber in Tennis Courts	3	0.21	4
Rubber Paints	7	0.48	10
Rubber Oil	14	0.96	18
Patents	46	3.17	73
Quebrachitol	12	0.83	15
Bleaching Agents	2	0.14	2
Orders for Chemicals, etc.	15	1.04	24
Miscellaneous	40	2.76	55
Total	1,449	100.00	1,805

Note. This analysis does not include letters on chemical subjects dealt with by the Technological and Advisory Division.

Interviews	264
Visits paid to Estates	52

TECHNOLOGICAL AND ADVISORY DIVISION

Analysis of Correspondence

Subject.	Letters received	Letters despatched
Latex Preservation	17	29
Latex Concentration	3	4
Latex—Instruments for determining D.R.C.	—	1
Rubber Preparation	3	4
Coagulation	2	7
Smoked Sheet	4	9
Smokehouses	1	6
Sole Crepe	1	2
Water samples	1	3
Machinery for Rubber Manufacture	4	16
New Uses of Rubber	1	1
Visits, Reports, etc.	14	36
Miscellaneous	9	11
Total	60	129

ANNUAL REPORT

SOILS DIVISION

STAFF

The strength of the staff in the Soils Division was not affected by leave during this year.

Routine Laboratory Work

The number of samples received for examination was higher than the previous year and the number of analyses about the same. The following comparison illustrates the output of work in the face of reduced staff.

	1931	1932	1933
Number of samples received ...	369	336	368
Number of analytical determinations ...	2742	3473	3770

The following summary indicates the nature of the routine work.

Colours of wet and dry soils	...	...	...	12
Moisture	...	...	...	34
Ash	...	...	...	141
Mechanical Analysis	...	...	...	92
Sticky point	...	...	...	34
Water soluble matter	...	...	...	10
Total solids	...	...	...	7
Exchangeable bases	...	...	...	216
Replaceable hydrogen	...	...	...	78
Electrometric pH	...	...	...	835
Colorimetric pH	...	...	...	299
Carbon	...	...	...	462
Nitrogen	...	...	...	472
Potassium	...	...	...	124
Phosphorus	...	...	...	180
Calcium	...	...	...	5
Iron	...	...	...	2
Aluminium	...	...	...	5
Silica	...	...	...	5
Arsenic	...	...	...	3
Manganese	...	...	...	4
Conductivity of Soil Extracts	...	...	...	750

Total number of determinations	3770
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Advisory Work

There was a considerable increase during the year in the demands for advice both by letter and by visiting. These calls are much influenced by the changes in the economic outlook. Thus, in the first six months of the year, the monthly averages of letters and visits were 37 and 10 respectively, while the figures went up to 68 and 15 for the second half of the year.

CORRESPONDENCE

The total number of letters sent out was 647—a considerable advance on the previous year. An analysis of subjects will be found attached to the Director's Report. The only significant change in trend is the increase under the head of 'replanting'. It is a very good sign that interest in this subject is increasing, and a later paragraph will be devoted to further comment.

VISITS

The total number of visits paid to estates was 156, which is more than twice the number in previous years. Part of this increase was due to the abolition of the former Field Division, in consequence of which scientific officers have been requested to do tours of visits. On these tours visits have been made to all estates in a district that expressed a desire for them. The Head of the Division made such tours in Sitiawan, South and Central Johore, while Mr. Akhurst made one in Kedah. This only accounts for part of the increased work: the requests for visits on special problems have also been much heavier.

FORESTRY METHODS

The interest in forestry methods continues to increase as the ideas involved become better appreciated. Sound and conservative ideas of soil management come to the fore, while hopes of sudden and phenomenal results recede. Plant specimens continually come in for identification and advice and, although there is often scant information to make this serviceable, in some cases it proves very useful in calling attention to special features. Thus we have received specimens of *Eupatorium odoratum*, which appears to have entered the country from Siam and to be spreading steadily. The most southerly point from which we have received it is central Perak. This plant appears attractive at first, its early growth being sappy but its later development is so vigorous that it becomes a dangerous pest in sufficiently open conditions.

The idea that special plants are to be feared because of their individual effects on the soil often crops up in advisory work, but seldom appears to be supported by the evidence. Thus soil samples were sent in by a manager who had become convinced from experience with *Mikania scandens* that it was making his soil more acid. Measurements showed that the soil from under *Mikania* was actually a little less acid than under *Centrosema*. Such slight differences in acidity as we have yet observed cannot be regarded as of importance under Malayan conditions. Another enquiry concerned the effects of oxalic acid, which is present in some plants and so might reach and injure the soil where these were grown. It may be stated that oxalic acid is a normal decomposition product of plant debris in its early stages, and as such might always be found in small quantities. It decomposes finally into carbon dioxide and water, so that, although excessive quantities might have a temporary effect on the soil, there would not be a permanent one. Until more is known however it is safer to rely upon a mixed flora than upon any single species.

WEED KILLERS

The abandonment of any form of control on uneconomic areas during the slump has led to the establishment of very strong growth of bracken and stagmoss in many instances. The difficulties in regaining control by ordinary hand labour have caused considerable interest to arise in artificial methods such as the use of weed-killers. It also happens that a revival of interest in the practice has taken place all over the world in arable farming.

The subject as applied to weed control in rubber has many limitations. The amounts of poisonous chemical which can be afforded are small, since the cost of hand labour with which they must be compared is so much smaller here than in farming in other countries; thus instead of 1 or 2 cwt. of chemical per acre as used for weeds on arable land we can only afford a few pounds per acre. Also the heavy rainfall, to which Malaya is subject, introduces a big hazard in the use of any form of water-soluble sprays.

Two poisons have proved to be of major interest, one being sodium chlorate and the other an arsenic preparation. The first named has been found, in low dilutions, (say 2 oz. per gallon), to have a selective action on weeds, attacking stagmoss and hairy leaves like those of Straits rhododendron, while leaving the smooth leaved shrubs like "wild coffee" unharmed. The injury effected by these small amounts extends only to the aerial parts and most plants shoot up again. The effect is somewhat similar to selective slashing and has much the same cost. Sodium chlorate seems

to hasten somewhat the rate of decay of the plant-tissues. It is not poisonous to animals and is therefore very safe to handle, the only danger being the remote one of rendering cloth which has been saturated with it more inflammable when dry. Repeated doses would be required to kill plants outright and the resulting cost would be uneconomic.

The arsenic weed-killer is more dangerous to handle and much more destructive in its effects on plants. Under the correct weather conditions it can kill bracken outright, but it does not solve the main problems of disposal of the debris (inflammable in dry weather) on which it has a slight preservative action. In wet weather, experiments with it have not been so successful, root systems escaping injury. The claim made that the soil is not injured is no doubt correct for the small quantities used, since delicate weed seedlings have been seen to appear very soon after its application.

The general conclusion seems to be that these sprays may be very useful as a preliminary to other work, (e.g. killing off the tops before digging out roots in lalang grass eradication), or as a method of keeping paths clear. But more experience will be required before it can be said that they have established any secure place in a scheme of control of natural covers.

MANURING

Although interest in manuring for mature rubber naturally remains in the background for economic reasons, it is encouraging that some of the older experiments are still kept under observation. It is important to realise that results are far-reaching and take a long while to work themselves out. Thus we have the following figures for girth increase in an experiment over six years old, which has received no manure for three years; control plots 0.5 inches increase in five years, manured plots 3.1 inches. The bark renewal, as might be expected, showed much better on the manured plots. The advantage to be expected in future tapping history is very plain. What better expression of stagnation could be required than the fact that increase in girth on control plots was under one hundredth of an inch per month?

In strong contrast with the slow results of manuring on mature rubber, most of the results with young rubber (where soil deficiencies exist) show very marked and quick response. In this connection it is important to note how easily a cover crop can take away the fertiliser intended for the rubber. Thus in one case at the Experiment Station where an organic fertiliser was mixed with the soil in the planting holes, the increase in growth under clean-

weeding conditions was 17 per cent, but under a well established cover this benefit was reduced to 4 per cent by competition, in spite of the usual ring-weeding round the trees.

REPLANTING

It should be realised that many areas of rubber present such poor soil conditions and such senility in the trees that the prospects of natural forestry means of restoration compare most unfavourably with the prospects of replanting. An improved economic outlook will therefore bring the subject very much to the fore, even though regulations may be made which, for the time being, restrict it.

Experiments in replanting in the past have not been altogether successful but the reasons are usually plain in the light of improved knowledge. Proper and regular manuring in the early stages of establishing the new stand will undoubtedly prove to be the key to the position. The young trees must be kept in a state of active growth and not allowed to lapse into a state of starved stagnation requiring special stimulation. The costs of regular manuring do not seem excessive in comparison with the total expense of a replanting programme, if the key position of manuring is realised.

Thus a correct programme would dovetail together the two major aims to be conducted simultaneously, namely, to build up a vigorous stand of budded rubber relying upon manuring in the early stages and to build up regenerated soil conditions by means of covers. At first this would entail keeping distinct two soil regions, the one round the trees in which they could benefit from manuring without interference and competition and the other under the cover where the tree roots will later extend.

MISCELLANEOUS

Several enquiries have been received on the value of smoke-house ashes as a fertiliser.

Where smoke-house ash is to be saved for use as a potash fertiliser it is important to protect it from the leaching action of rain, since the potash is very soluble. In one case, where samples were sent in for examination, the action of rain had reduced the potash content from 11 to 1 per cent.

In one case a good instance was afforded in support of the growing realisation that the bad effect of tapioca crops upon the rubber subsequently established is due more to the injury of the cultivation methods, (loss by erosion), than to the removal of plant nutrients by the tapioca. In a case where very good results with

rubber were being obtained, after crops of tapioca had been removed, the soil was examined to see whether it had specially good mineral reserves. These proved to be by no means above the average and the good results are attributed mainly to the fact that careful soil conservation work was practised immediately the last tapioca was removed.

Leaf samples from one estate were found to contain a very high proportion of manganese. The matter upon which advice had been sought was the very poor bark renewal shown by some trees of otherwise good development. The above was the only unusual feature which could be found in the situation and, although the connection cannot be explained at present, it may be recorded as a matter of interest. The leaf ash contained 0.5 per cent of manganese, a proportion as high as that in rubber seedlings which had been killed by the toxic effect of manganese in culture solution in certain of our laboratory experiments. The amount of manganese in the surface soil, however, was not abnormal, nor did the trees show any of the usual signs of physiological injury.

Field Work

NEW CULTIVATION EXPERIMENTS

The most important new departure during the year was the inauguration of a series of cultivation experiments designed to give information on the various points at issue in the modern methods of cultivating rubber. Since there are so many variations in all factors concerned, such as soil, climate, previous history of cultivation and predominant weed species, it was found necessary to distribute experiments about the country and to ask co-operation from various estates. The terms of the co-operative work include the bearing of all expense by the Institute and an agreement by the management not to abandon the experiment for a period of five years. Under this arrangement some 11 experiments have already been laid down. The Division also follows closely the progress of similar experiments conducted on 30 other estates.

A typical experiment designed to investigate the treatment and effects of bracken (*Gleichenia linearis*) may be described as an example. The aim was to establish the facts regarding the much discussed deteriorating influence of bracken and to have under careful observation practicable methods of dealing with areas in which it is established. The plots therefore included the following treatments: (A) clean weeded as control, (incidentally this provided a good illustration of the costs of clearing), (B) bracken

left uncontrolled, (C) bracken slashed and replaced gradually by selective weeding, (D) bracken slashed and replaced by a planted cover. Twelve plots were laid down each consisting of one task of 3 acres, giving the above treatments replicated three times in randomised blocks. Records include the girth of every tree at yearly intervals and also yields of each plot. On the D plots *Indigofera endecaphylla* was planted along cleared strips with a complete fertiliser, in the hope that it might develop and be used with due assistance to smother the bracken. This was undertaken at the express wish of those who felt that legumes should still be tried in old rubber. However, after getting well established, the *Indigofera* died out completely again. This happened during a wet growing season and was undoubtedly due to the fact that the *Indigofera* could not stand up to the fierce competition of the situation. It grew while it could draw upon the fertiliser specially supplied to cultivated patches but, as soon as the rubber could develop the necessary roots into these patches, it took all the remaining benefit. The extra development of roots in the manured areas was very apparent. A new endeavour will therefore be made with some form of natural shrub which is better adapted to the poor soil conditions. A collection of *Fagraea* seed is being made for this purpose.

In another bracken experiment the aid of nitrogenous fertilisers (calcium cyanamide and ammonium sulphate) is being used, not only to improve shade for control but to depress the undersized plants by the scorching effect at the time of application. Similar experiments with methods adapted to the varying situations are laid down in areas covered with stagmoss (*Lycopodium*) and in typical cases of mixed natural covers.

LAKE GARDENS, KUALA LUMPUR

The area of rubber in the Lake Gardens, Kuala Lumpur, continues to afford opportunity for experimental observation on questions of rejuvenating old rubber, though the provision of a re-planting demonstration here has been ruled out.

In particular, a test has been laid down to see by what stages and how quickly trees in an apparently hopeless state of die-back and stagnation can be brought to recovery by an entirely liberal, (if uneconomic), supply of organic fertiliser.

EXPERIMENT STATION

Interesting development continues to be made at the Experiment Station, of which accounts appear regularly in the Journal.

Early in the year a change was made in Block 11 which had been allowed to grow in secondary jungle, one half slashed and the other half unslashed. It had become apparent that the rubber was definitely becoming retarded, so part of each treatment was cleared and maintained weeded. The growth since clearing has been very good—about 5 inches increase in girth in six months as compared with about $3\frac{1}{2}$ inches for most other clean-weeded plots. This indicates that there was a definite stimulus produced by the residual effects of the removed cover. The debris was removed from the plot at the time of clearing but the old root systems remained in the soil. Actually the whole of this block has recovered somewhat and the indications are that the marked set-back was associated with the period of first wintering but is not continuing.

There seems to be some mis-apprehension about Block 11 being an exhibition of the so-called forestry methods. This would hardly be a correct description, since it was originally laid down to study the development of root disease under a return to jungle conditions, and no planter would have undertaken to grow rubber with such little control. Valuable object lessons are however being afforded, of which two now stand out clearly, namely (1) that competition from a mixed natural cover can effectively reduce growth of the rubber even in a virgin soil (2) that improvement in soil fertility is secured by the growth and subsequent decay of roots of natural covers.

Only one other experiment calls for special comment in this report. On Block 17 observations are being made on the first year's growth of rubber planted on land which had been for some years under strips of various legume covers. These were not removed, but the young plants were ring-weeded in the conventional way. The development is best among the shrub-type covers, and worst among the vigorous growth of the ground covers—*Mimosa* and *Centrosema*.

Laboratory Work

With decreased staff and increased demands from outside, the laboratory work has more than ever been restricted, but routine analysis has been actively maintained.

The results from analysis of the first 1500 soil samples in our records were statistically examined. The following are the modal values of the frequency distribution of the commoner determinations. The modal value is the one that occurs most frequently, and is not quite the same as an average value.

Phosphate	...	...	180 parts per million
Potassium	...	...	200 " " "
Nitrogen	...	...	1050 " " "

Carbon/nitrogen ratio, two modes at 11.5 and 16

Acidity values (*pH*) usually between 4 and 5.

These values are not of great significance until they can be subdivided for different soil types, but it may be said that the great preponderance of samples were from primary soils on undulating and hilly land.

A considerable part of the analyst's time is occupied in the examination of quarterly samples from the lallang grass experimental plots at Serdang and Klang. The collection of typical soil profile records has been added to during the year. It was found necessary, also, to give a little time to a critical examination of the cobaltinitrite method for potash determination and our routine technique was found to be quite accurate.

The main research that has engaged the attention of the Division concerns the problems of the restoration of organic matter to eroded soils. For several reasons it is natural to begin the attack by a study of the different kinds of debris from which the raw humus of the "forest floor" is derived, and of the processes followed in the decay which passes on the components to the soil, mainly through leaching of rain. This is the line being followed in our work, and a paper has already been published on the acidity and buffer capacity of a number of plant residues.

A minor investigation was made into the relative amounts of water transpired by some of the commoner natural covers. The results showed that stagmoss and, to a rather less extent, bracken transpire much more moisture from the soil than do shrubby covers. Considering the very superficial root habit of stagmoss in particular, and of the rubber itself in the situations where stagmoss predominates, it is likely that the presence of much stagmoss would help to reduce latex yields during dry spells.

Further work was pursued on the question of utilising *Fagraea* seed for producing a natural cover of this species. It was shown that a yield of seed of from 5 to 7 per cent of the weight of ripe fruit is obtainable. The seeding seasons correspond to the two dry periods (July—August, and February—March). The seed is very small and averages about $1\frac{1}{2}$ million to the pound. Germination tests have given varied results, but usually germination has begun after standing on wet soil for 30 days and has given 5 to 30 seedlings per 100 seed. The prospects of being able to secure a close cover of this plant by artificial sowing are therefore distinct-

ly promising. Pre-treatment of the seed to hasten germination has so far not proved to be ultimately advantageous. In some cases attempts have been made to secure establishment by transplanting seedlings of *Fagraea*, in the hope that these plants will ultimately be seed-bearers. It must be remarked, however, that all seed-bearers so far examined have been in very damp situations and the younger plants at any rate die back a good deal at the tips (which bear the flowers) in dry weather in well-drained land.

Co-operation

Occasion arose during the year in which the Division was able to assist each of the other Divisions in some line of work. The Botanical Division was provided with the necessary meteorological instruments for observations on the new tapping experiments, and their installation supervised. The Pathological Division requested help over certain sulphur dusting experiments with *Oidium*, and soil examinations were made over the areas concerned to provide a better background for the interpretation of results. It cannot be doubted that poor nutrition much enhances susceptibility to this disease. In conjunction with the Chemical Division, information was collected concerning the relationship between the phosphate status of the soil carrying the rubber trees and the phosphate content of the latex yielded.

Lectures

Six lectures were delivered during the year—four by the Head of the Division and two by Mr. C. G. Akhurst. One was on re-planting problems and the others on natural covers.

	<i>Place</i>	<i>Auspices</i>	<i>Subject</i>
W. B. Haines	Malacca	Sime, Darby & Co.	Forestry
	Taiping (Perak)	Incorporated Society of Planters.	Replanting
	Sitiawan (Perak)	Incorporated Society of Planters.	Forestry
	Rengam (Johore)	Johore Planters' Association.	
C. G. Akhurst	S. Patani (Kedah)	Kedah Planters' Association.	"
	Lunas (Kedah)		"

Publications

- (1) "Natural Growths in Reference to Soil Conditions" R.G.A. Bulletin, Vol. 15, No. 7, July 1933 by W. B. Haines
- (2) "Note on the Bearing of Certain Meteorological Factors on Agriculture in Malaya". Fifth Pacific Science Congress 1934, by W. B. Haines
- (3) "Effects of Covers and Cultivation Methods in Young Rubber. IV. R.R.I. Journal Vol. 5, No. 1.
- (4) "Note on the Acidity of Raw Humus in relation to Natural Covers", R.R.I. Journal Vol. 5, No. 1 by W. B. Haines and K. S. Pillai
- (5) "A Note on Manganese in Malayan Soils" R.R.I. Journal, Vol. 5, No. 1 by C. G. Akhurst.

Summary of Rainfall, 1933

			Experiment	
			Station	Laboratory
January	...	...	6.06	5.22
February	...	...	6.69	14.67
March	...	...	19.17	14.33
April	...	...	16.35	12.74
May	...	...	9.41	16.45
June	...	...	2.76	5.61
July	...	...	4.62	4.98
August	...	...	4.65	— *
September	...	...	10.16	—
October	...	...	6.56	—
November	...	...	11.40	—
December	...	...	14.75	—
Total			112.58	
Previous year's total			107.27	

*Rain Gauge removed from the Institute for other experiments on the 29th July, 1933.

Acknowledgements

Our thanks are due and most cordially offered to the numerous managers who have co-operated in building up the knowledge and experience required to guide the industry in its change to new methods of cultivation.

W. B. HAINES
Head of Soils Division

ANNUAL REPORT

BOTANICAL DIVISION

During the year ending December 1933 the work of the Botanical Division was continued on the general lines described in the Annual Report for 1932. In certain directions it has been possible to increase the scope of investigations and to initiate additional studies on the main subjects of research. Rapid increase in the volume of field work entailed in connection with the experiments in progress on the Experiment Station at Sungei Buloh has necessitated curtailment of advisory and experimental work on estates. This development was to be expected; in the early years, before facilities for field experiments under our own direct control were available, it was necessary to obtain the collaboration of outside estates in the conduct of field experimental work. Although in this connection the assistance rendered by many estates has been extremely valuable it is clearly desirable that, in the conduct of critical experimental work, complete control of experimental areas should be obtained. The Division is now adequately equipped with the necessary facilities in both mature and immature rubber for the conduct of the major portion of the investigations in progress.

The transfer of another senior officer to the division has made it possible to undertake further work on the physiology of *Hevea* in relation to latex production and in this direction important advances have been made.

The general organisation of the work of the Division was discussed and commented upon favourably by the members of the Commission of Enquiry in the course of their investigations.*

STAFF

The senior staff of the Division has been augmented by the transfer of Mr. H. Gunnery, who has undertaken special investigations on the physiological anatomy of *Hevea*. Mr. Gunnery took up his appointment on May 3rd, 1933. No other changes in staff have been made during the year.

* Report of the Commission of Enquiry into the Constitution, Administration and Working of the Rubber Research Institute. Page 20. Sections 79 and 80. 1933.

Reports of Investigations in Progress

In the present report, in order to facilitate reference, the same form of presentation as that adopted in the report for 1932 has been followed.

1. Vegetative Propagation

(1) TECHNIQUE OF BUDDING OPERATIONS

A modified method of budding, particularly suitable for use in budding large stocks, has been developed. The new method resembles the Garrot method described in the last annual report. Old motor car tyres are cut into strips about 3 inches long by 1 inch wide. A single strip is bound firmly in position over the patch and tongue using strong string or strips of rotan. The results obtained have been excellent and the method is cheaper in operation than either the Garrot or the normal waxed bandage method.

H. W. Foster

(2) AFTER-CARE OF YOUNG BUDDINGS

Work on the treatment of pruning cuts at the union of scion and stock has been continued. The results confirm the suggestions made in the report for 1932. The most satisfactory rate of healing has been obtained by the use of a steep pruning cut, the slope being not less than 45 degrees, followed by careful trimming of the cut to expose a clean, smooth surface. The application of all protective and fungicidal dressings, which have been tested so far, has been shown to retard and in certain cases to prevent healing over of the exposed wood surface of the stock at the point of union. Shade has been shown to accelerate the rate of callus growth and healing. The full results of these investigations have been published in the *Journal* (Vol. 5 No. 2, pp 152—158) 1934.

C. C. T. Sharp

(3) VEGETATIVE PROPAGATION OF STOCKS

One of the chief causes of variation in growth and yield of the trees within a single clone is the nature of the stocks used in budding. The stocks are normal seedlings of mixed parentage and therefore exhibit the wide range in characters, in particular vigour of growth, characteristic of a normal seedling population. The vigour of

the seedling root system is an important factor in determining the size of the scion and indirectly, the yield of the scion. Clonal stocks are used in fruit cultivation to overcome this difficulty and to ensure uniformity in growth and performance of the trees. Experiments have therefore been initiated with seedlings and buddings of a large number of different clones to explore the possibilities of producing stocks of a common origin which may be suitable for budding work. Layering and pollarding followed by earthing-up to encourage root formation by bleaching (etiolation) has been carried out. Negative results have been obtained so far but the experiments are being continued.

C. E. T. Mann

(4) STUDIES IN THE GROWTH OF BUDDED TREES

(a) *Comparison of the growth of buddings of different clones under the same conditions on virgin soil*

In continuation of previous reports* a summary of the growth records taken on the Clone Trial Block (R.R.I. Experiment Station, Block 5) is given in Table I. All clones show a satisfactory rate of growth with the possible exception of clone B.D.5. This clone appears to be ill suited to the open, sandy soil of the flat area of the Experiment Station.

TABLE I. *Growth of Buddings of different Clones under uniform Conditions, age 3 to 4 years*

Plot Index	Clone	Mean girth in inches		Mean spread of crown in feet	
		Dec. 1932	Nov. 1933	Dec. 1932	Nov. 1933
A.	A.V.R.O.S 152	8.7	12.6	8.4	12.6
B.	„ 49	9.6	13.2	8.5	12.5
C.	Prang Besar 23	7.9	11.7	7.9	12.6
D.	„ „ 186	10.4	14.1	9.8	15.0
E.	Bodjong Datar 5	7.8	10.2	3.3	7.0
F.	Tjirandji 1	9.4	13.5	9.1	13.7
G.	Pilmoor A. 44	9.0	12.3	7.3	11.9
H.	„ B. 84	10.0	14.4	10.1	14.3
J.	A.V.R.O.S 50	8.8	12.5	7.5	13.3

* Progress reports in Annual Reports of the R.R.I. of Malaya 1929, p.54; 1930, p.59; 1931, p.54; 1932, p.59.

(b) *Comparison of the Growth of Buddings of different Clones on a replanted Area*

Previous reports of this work * have demonstrated a relatively slow rate of growth of all buddings under the conditions of experiment. In Table II the summarised growth records for the year 1933 are presented and a comparison is made between the rate of growth of five of the clones included in this test on virgin and replanted areas.

TABLE II. *Comparison of Rate of Growth of budded Trees on virgin and replanted Areas of similar Soil Type*

Plot Index	Clone	Age 3½ years.	Girth measurements ins.	
		A. On replanted area	B. On virgin soil	Ratio $\frac{B}{A}$
A.	A.V.R.O.S 49	6.5	11.1	1.7
B.	„ 50	6.2	10.2	1.6
C.	Bodjong Datar 5	6.0	8.6	1.4
D.	Tjirandji 1	6.4	11.2	1.8
E.	Pilmoor B. 84	6.2	12.1	2.0
F.	Glenshiel 1	6.2	—	—

In both experiments planting was carried out with budded stumps of the various clones.

Although there has been a noticeable improvement in growth on the replanted plots it is clear that, to encourage vigorous growth and so reduce the length of the unprofitable period between replanting and production, special treatment of replanted areas may be necessary.

After consultation with the Soils Division it was decided to test the effects on growth of manuring with nitrogenous and phosphatic manures and special cultivation. Accordingly, in July 1933 all plots were divided equally, the trees in one half of each plot were manured with 2 lbs. rock phosphate and 1 lb. sulphate of ammonia per tree and in the other half the mixed cover of leguminous plants and soft grasses was turned into the soil in strips 12 feet wide between the tree rows. Growth measurements were taken six months after the treatments and a summary of the results is given in Table III.

* For previous reports of this work see Annual Reports of the R.R.I. of Malaya, 1930, p.62; 1931, p.57; 1932, p.60.

TABLE III. *Comparison of the Effects of Manuring and Cultivation on the Growth of Buddings in a replanted Area*

Plot Index	Clone	Mean Girth per tree in inches					
		Cultivated			Manured		
		Dec. 1932	Feb. 1934	Increase per cent.	Dec. 1932	Feb. 1934	Increase per cent.
A.	A.V.R.O.S 49	3.1	5.9	90	3.2	6.1	91
B.	„ 50	3.5	6.0	71	3.6	6.2	72
C.	Bodjong Datar 5	3.3	5.4	64	3.9	6.3	62
D.	Tjirandji 1	3.5	6.5	86	3.0	6.0	100
E.	Pilmoor B. 84	2.9	5.7	97	3.1	6.0	94
F.	Glenshiel 1	3.3	6.0	82	3.4	6.2	82
	Mean of all clones	3.3	5.9	79	3.3	6.1	85

Both cultivation and manuring have had a marked beneficial effect on growth and there is a slight indication that manuring has proved the more beneficial treatment.

C. E. T. Mann

(c) *Comparison of the Growth of Buddings of proved Clones under different Conditions on Estates*

Further records of growth of budded trees of a number of clones have been obtained from some 30 different estates during the year. In general they confirm the results recorded in the Annual Report for 1932, p. 61—62. Observations on the clone trial block on the R.R.I. Experiment Station (reported in (a) of this section) have shown that after the first $1\frac{1}{2}$ years the rate of growth increase is remarkably steady and the growth curve approximates very closely to a straight line. In Table IV therefore, the time taken for each clone to reach tappable age is estimated on the basis of growth measurements made so far. The standard of girth adopted as the criterion for commercial tapping is 20 inches at a height of 40 inches from the union. Each record refers to the mean of 25 to 75 trees measured at the same time.

TABLE IV. *Comparison of the Rate of Development of different Clones under average Conditions*

Clone	No. of records	Age at which the clone should reach the tapping stage
A.V.R.O.S. 49	24	4 years 7 months
.. 50	26	5 " 1 "
.. 152	16	5 " 7 "
.. 256	12	5 " 6 "
Bodjong Datar 5	20	5 " 10 "
" " 10	7	5 " 1 "
Tjirandji 1	11	5 " 3 "
Prang Besar 23	9	5 " 2 "
" " 25	7	5 " 0 "
" " 186	11	5 " 0 "
Sungei Reko 9	25	5 " 6 "

TABLE V. *Comparison of the Growth of different Clones under different environmental Conditions*

Area	Soil and other conditions	Growth as percentage of mean growth			
		A.V.R.O.S. 49	A.V.R.O.S. 50	A.V.R.O.S. 152	B.D. 5
A	Light sandy clay	91	94	105	100
B	Light, lateritic Manured with ammonium sulphate	107	125	132	104
C	Heavy laterite	96	88	133	—
D	Hilly, sandy, clay subsoil	88	96	102	—
E	Sandy with clay subsoil. Budded on 3-4 years old stocks. Heavy cover of grass	—	85	91	97
F	Sandy, clay subsoil Heavy cover of <i>Centrosema pubescens</i>	—	68	52	83

The rate of growth of different clones is affected to a varying extent by different environmental conditions. This is illustrated by the growth records shown in Table V. for clones A.V.R.O.S. 49, 50 and 152 and clone Bodjong Datar 5. For each clone, the mean growth on all recorded areas is taken as 100 and the actual growth under the

varying conditions is shown as a percentage of the mean growth.

The four clones compared in Table V. have been selected to show the wide variation in growth obtained under different conditions. Clone A.V.R.O.S. 152 shows the greatest range of variation and appears to be one of the clones most sensitive to changes in environment. Fewer observations have been taken for clone P.B. 25 but this clone appears to share the sensitive character of clone A.V.R.O.S. 152. The next or medium group contains clones A.V.R.O.S. 50, 256 and Tj. 1, whilst the group of clones showing very uniform growth under all conditions contains clones A.V.R.O.S. 49, B.D. 10, P.B. 23 and 186 and S.R. 9.

Clone B.D.5 is in a class of its own for it appears to be the least affected of any clone by changes in environment. It is suggested that this uniform growth is connected with its late branching habit. This late branching and consequent lack of soil shade may produce a retarding effect on growth which will tend to mask differences in soil fertility.

C. C. T. Sharp

(d) *The Influence of Density of Planting on the Growth and Development of budded Trees*

Observations and measurements have been continued on the "density of planting" experiment with clone A.V.R.O.S. 50 (R.R.I. Experiment Station Block 14 C & D). Summaries of the 1933 growth measurements, together with those for 1932 for the purpose of comparison, are presented in Table VI.

TABLE VI. *Density of Planting and Comparison of the Growth of budded Trees of Clone A.V.R.O.S. 50*

Plot Index	Planting Distance in feet	No. of trees per plot	Mean girth per tree in inches	
			Dec. 1932 Age 2 years	Dec. 1933. Age 3 years
A	30 x 30	54	4.8	8.0
B	20 x 20	117	5.1	8.3
C	14 x 14	247	4.9	7.8
D	12 x 12	320	5.1	8.1
E	10 x 10	468	5.2	8.1
F	20 Δ	125	5.1	8.2

There has been a general evening up in growth during the year under review and at the end of 1933 there was no significant difference between the mean girth of the trees at all densities. In other words, it looks as though the initial advantage of dense planting is being lost owing to the effects of over-crowding and competition. A note of warning regarding the interpretation of the results of this experiment is necessary. The experiment is being conducted with a single clone, and therefore the results should not be given too general an interpretation. The budding of clone A.V.R.O.S. 50 is a characteristically slender, small-crowned tree and it is possible that a more bushy type of tree, e.g. A.V.R.O.S. 152 or Tjirandji 1, would have shown the ill-effects of over-crowding at an earlier age.

C. E. T. Mann

(e) *Growth and Development of budded Trees in mixed Plantings*

Growth studies in mixed plantings of buddings and seedlings, in mixed plantings containing varying numbers of proved clones unmixed with seedlings and in monoclonal plantings have been continued.

In April 1933 a further experimental plot of 22 acres was established for the study of duo-clone planting (R.R.I. Experiment Station, Block 20). The planting density is 196 trees per acre. Alternate trees have been budded with an old-established clone and the intermediate trees with a new and very promising clone which has not yet been sufficiently well tested to be used in monoclonal planting. The object of this method of planting is to investigate a means of establishing monoclonal plantings of promising new clones without delay. Eight new clones are being studied in this experiment in comparison with an equal number of the best clones at present available for commercial monoclonal planting.

C. E. T. Mann

(f) *Estate Experiments*

It has not been possible to commence the tapping tests on the estates on which field experiments were initiated in 1928 and 1929. Small-scale experiments, arising mainly out of advisory work on estates, have been

TABLE VII. *Correlation between Stock Vigour, as indicated by Stock Size, and Growth of Scions grafted upon them (R.R.I. Exp. Station, Block 22A.)*

Clone	No. of trees	Girth of Stock 1932 (Dec.)			Growth of Scions 1933 (Dec.)			Coefficient of correlation between size of stock and growth of scion
		Mean Cm.	Standard Deviation	Coefficient of variation	Mean height Cm.	Standard Deviation	Coefficient of Variation	
A.V.R.O.S 49	90	20.8	± 6.92	33	349	± 78.75	23	+ .3122
P. B. 186	103	19.6	± 5.60	29	268	± 52.50	20	+ .2253
Tj. I	114	20.2	± 5.80	29	307	± 72.50	24	+ .4915
A.V.R.O.S 152	111	20.2	± 5.50	27	220	± 58.25	26	+ .3188
Rubana 393	104	20.0	± 6.14	31	298	± 69.50	23	+ .5660

undertaken whenever possible. These have been chiefly concerned with comparative tapping tests on young budded trees in mixed plantings or in clone testing areas established in 1928 and 1929. Since the ultimate aim of the study of vegetative propagation in *Hevea* is the study of production of the various clones under different conditions it is desirable to extend work of this nature. The value of results from such work is entirely dependent on the careful organisation and correct initial planning of the tests and in this the Institute might give useful assistance.

C. E. T. Mann

15. THE MUTUAL RELATIONSHIP BETWEEN SCION AND STOCK IN BUDDED TREES

(a) *Influence of Stock Vigour on Growth of Scion*

Previous studies of this subject have been published in the Annual Reports for 1931 and 1932.* A further study was completed during the year and the results confirm those obtained by Mr. Billington and reported last year. In Table VII, an analysis of detailed growth measurements of stock girth and scion growth is given.

The coefficient of variability of growth of the stocks indicates that, at the time of budding, the stocks showed a wide range of vigour. In view of this, the smaller variation in the growth of buddings made upon them is noteworthy. It would appear that, in a young budding, the scion soon becomes the dominant member of the partnership and the common origin of the scions is reflected in their uniform rate of development. At first sight these results appear to be in conflict with the accepted practice of budding upon seedling stocks selected on the basis of growth vigour. This is not true in practice for our records of budding work consistently show that a much higher percentage of successes is obtained on vigorous stocks than on stocks of moderate or slow growth.

C. E. T. Mann

* Annual Report. R.R.I. of Malaya 1931, p.58; 1932, p.64.

(b) *Influence of Scion on Yield of Stock*

- (i) During the year the establishment of the field experiment on "high" budding described in the last report, (R.R.I. Experiment Station, Block 10) was completed.
- (ii) Twin plants for further development of this work have been successfully established with clonal seed (R.R.I. Experiment Station, Blocks 4C, 25 and 22B.)
- (iii) A preliminary tapping test on scion and stock of buddings made on 3 years old stocks was carried out in November 1933 on an estate. The scions were 3 years of age. The tests will be repeated at intervals of six months.

C. E. T. Mann & K. N. Kaimal

(c) *Use of special Stocks for budding with Hevea brasiliensis*

The establishment of isolation gardens for the production of seed of *Hevea spruceana* and *Hevea spruceana* $\times$ *Hevea brasiliensis* was completed during the year. The buddings are making excellent growth under semi-jungle conditions.

(d) *Study of the Latex Vessel Systems in Scion and Stock*

Following the work on this subject reported last year, tapping experiments have been carried out. Buddings of four clones have been tapped across the union and at a height of 32 inches above the union.

A positive decrease in yield at the region of union is found in Pilmoor Estate clones B. 84 and B. 16. In clones B. 58 and A. 44 there is little significant difference in yield at the two levels. It is interesting to note that the former two clones show a low degree of correlation between girth and yield at the region of the union whilst for clones B. 58 and A. 44 the correlation is high.

In Table VIII. the actual production from the high cuts and from the cuts at the union is shown. Girth measurements at the different tapping levels were also taken and the correlation between girth and yield at different heights has been worked out.

TABLE VIII. *The Relationship between the Yield of Scion and Stock in Buddings*

Clone	Yield in grams dry rubber per tree per tapping		Correlation between girth and yield	
	High cut on Scion	Low cut on Stock	High cut on Scion	Low cut on Stock
A. 44	25.7	29.2	+ .86	+ .63
B. 58	39.0	40.3	+ .77	+ .73
B. 84	65.4	44.4	+ .74	+ .39
B. 16	57.4	49.6	+ .93	+ .43

Tapping carried out daily in September 1933 on single half circumference cuts at 32 inches and across the union of scion and stock bark.

The results summarised above suggest that

- (a) different scions may influence the properties of the stock to different degrees
- (b) the very high average yields obtained mainly from stock bark below the point of union suggest a positive influence of the scion on the latex producing properties of the stock.

C. E. T. Mann & K. N. Kaimal

2. The Physiology of *Hevea brasiliensis* in relation to Latex Production.

The work described under this section has been extended to include investigations of the physiological anatomy of *Hevea*; in other respects the scheme of investigations described in the report for 1932 has been followed.

(i) TAPPING EXPERIMENTS ON MATURE TREES GROWN FROM SEED

(a) *Lake Gardens Experimental Area*

Work on the Lake Gardens area has developed as follows:

- (i) Normal alternate-day tapping over the whole area has been carried out in order to obtain a datum line by which to judge the effects of future treatments.

(ii) Small-scale experiments to provide material for anatomical study in conjunction with the work in progress on the Seventh Mile Estate reported below.

(iii) Experiments on influence of the slope of cut on yield; influence of one cut upon a second cut.

(iv) Botanical study of the progress of repopulation of eroded areas.

The history of the original planting of this area is imperfectly known, the age of the trees varies from 25 to 30 years and the treatment of the trees has not been uniform. The area was divided into blocks in 1932 on the basis of general appearance of the trees and, so far as it was possible to judge, the previous history of the plots.

A summary of the results of the uniformity test carried out for one year is given in Table IX.

TABLE IX. *Record of Yield of Observation Plots. Tapped alternate-daily on half circumference for one year*

Plot.	Acreage.	No. of trees per acre	Yield per acre lbs. per annum	Yield per Tree lbs. per annum
A	5.87	55	266	4.9
B	2.09	66	496	7.6
C	2.67	60	755	11.3
D	5.95	61	660	10.9
E	1.76	54	615	11.4
F	1.45	67	500	7.5
H	1.40	119	689	5.8
J	1.76	63	394	6.3
K	2.06	64	694	10.9
L	3.44	50	610	12.2

The figures illustrate the extremely heterogeneous nature of the area and demonstrate its unsuitability for detailed experimental work other than work of a purely observational character.

C. E. T. Mann

(b) *Economic Tapping Systems*

An experiment to compare different economic tapping systems was set up on Seventh Mile Estate, Selangor, and

tapping and recording commenced on June 1st, 1933. An outline of the scheme of the experiment was given in the Annual Report for 1932 and a full account of the work is being prepared for publication in the Journal.

A summary of the results of the first six months tapping is given below.

The tapping systems under test are:—

		<i>Months tapping-</i>	<i>Months rest</i>
1.	A.B.C. Alternate-daily	6	3
2.	A.B.C. " "	10	5
3.	A.B.C. " "	14	7
4.	Two cuts third-daily	3	3
5.	" " " "	5	5
6.	" " " "	7	7
7.	Two cuts fourth-daily without rest.		
8.	Alternate-daily without rest. (control)		

Each plot consists of a full tapping task and there are six replications of each plot. All tapping cuts are "V" cuts on half the circumference of the tree.

The yields from each tapping system of first-grade rubber, scrap and total dry rubber, are set out in Table X.

TABLE X. *Total Yield per Acre (June to November 1933.)*

Tapping System	Yield of First Grade Rubber		Yield of Scrap		Total Yield of dry Rubber	
	lbs.	Per cent. of control	bs.	Per cent. of No. 1	lbs.	Per cent. of control
1	219.4	68.3	21.1	9.6	240.5	68.1
2	217.0	67.6	21.4	9.8	238.4	67.5
3	207.4	64.6	19.4	9.4	226.8	64.2
4	171.6	53.4	25.8	15.0	197.4	55.9
5	182.7	56.9	25.4	13.9	208.1	58.9
6	186.4	58.1	28.6	15.4	215.0	60.9
7	309.4	96.3	57.4	17.7	366.8	103.1
8	321.2	100.0	31.9	9.9	353.1	100.0

The experiment has been laid out in such a manner that the results may be analysed by recognised statistical methods. The standard error is 10.5 pounds. Twice the standard error is used as a test of significance, so that differences between treatments of less than 21 pounds per acre must be regarded as being due to chance and not to a difference in the tapping systems.

C. C. T. Sharp

TABLE XI. *A Summary of the Results of some Estate Experiments with Double-cut Tapping Systems*

No.	Age of trees in years	Duration of Expt. in months	Tapping Systems		Yield (lbs. per acre) over period of Expt.		Yield per tapper lbs. per tapping		Ratio of Expt. to control = 100
			Experiment	Control	Expt.	Control	Expt.	Control	
1	12	19	Two cuts third daily. Half circ. Tap. 6 months Rest 6 "	Single $\frac{1}{2}$ circ. cut. Alternate daily.	740	902	15.1	11.6	82
2	mature	15	do	Single $\frac{1}{2}$ circ. cut. Alternate daily ABC.	536	472	22.9	17.7	129
3	14	18	do	Single $\frac{1}{2}$ circ. cut. Alternate daily.	619	814	15.3	11.1	76
4	13	15	do	do	466	479	11.9	7.5	97
5	15	15	do	do	598	727	14.4	9.9	82
6	14	20	do	do	783	992	21.3	—	79
7	7	17	Tap. 4 months Rest 4 "	Single $\frac{1}{2}$ circ. cut. Alternate daily ABC.	320	331	8.9	6.8	97
8	5 $\frac{1}{2}$	10	do	do	109	162	5.0	5.7	67
9	14	12	Two cuts on $\frac{1}{2}$ circ. tapped fourth daily without rest.	Single $\frac{1}{2}$ circ. cut. Alternate daily	555	531	13.3	11.5	104
									116

Note. 1. The Control areas. The records of yield in the control areas are taken as follows.

Exps. 1 & 2, another field of the same age and, so far as is known, of the same yielding capacity.

Exps. 3, 4, 5, 6, Previous yield records from the same field.

Exps. 7, 8 & 9, Control tasks scattered at random amongst the experimental tasks.

Note. 2. In experiment No. 2 the age of the rubber is not known but it was certainly over 20 years.

(c) *Tapping Experiments on Estates*

In the Annual Report for 1932 reference was made to experiments on double-cut tapping systems carried out on estates.

Records for a number of these estate experiments are shown in Table XI.

Experiments 1, 3, 4, 5, & 6

All these experiments have been in progress for over a year. The loss in crop varies from 3 to 24 per cent with an average of 17 per cent. Whereas the yield per tapper (omitting No. 6.) has increased by 30 to 59 per cent with an average of 43 per cent.

Experiments 7 & 8

The results from these two experiments on young rubber disagree considerably. No. 8 was abandoned after ten months as unsatisfactory. No. 7 is still being carried on but, although the percentage figures appear very satisfactory, an average yield of just under 9 lbs. per tapper would not be profitable during periods of very low prices.

The general conclusion to be drawn from these experiments are that the two cuts third-daily A.B. tapping system (The Sunderland System) appears to be very promising for use on mature rubber during periods of very low prices but that it is very doubtful whether it will be of equal value on young rubber.

Experiment 9

Two half-circumference cuts tapped every fourth day without rest (Double-Four). The figures given in Table XI. are for first-grade rubber only. The figures for total weight of dry rubber, including scrap, are 693 lbs. and 659 lbs., being in the proportion of 100: 105 for the alternate-daily and "double-four" systems respectively.

The yields for the first six months (first-grade rubber only) for the double-four and the control were 223 and 224 lbs. respectively, being in the proportion of 91.3: 100 compared with 96.3: 100 on Seventh Mile Estate, (See Table IX) which is a very close agreement.

We must again record our thanks to the following for supplying us with much valuable information with regard to double-cut tapping systems, Mr. S. B. Palmer, Bruas Estate, Perak; Mr. J. C. Innes, Straits Rubber Co. & Allied Cos; Mr. J. Murray; Mr. C. H. Green, Tuan

Mee Estate, Selangor; Mr. A. P. Cranna and Messrs. Guthrie & Co.

C. C. T. Sharp

(2) TAPPING EXPERIMENTS ON BUDDED TREES

(a) *Study of Budded Trees under normal Tapping Systems.*

The main experiment in progress on the experimental area on Pilmoor Estate, the aim of which is to obtain experience in the tapping of budded trees and to study any peculiarities of behaviour which may be observed, has been continued as in previous years.* In December 1932 the tapping cuts opened in April 1929 reached the level of the union. The panel was originally opened at a height of 36 inches and provided 54 months continuous tapping. The new panel was opened on January 1st, 1934 with a single left to right cut at a height of 40 inches from the union above the test-tapping panel opened originally in January 1928.

Growth

The experimental block is established on a light, sandy quartzite soil where, to judge from the adjoining mature rubber areas, growth is not particularly vigorous. The rate of growth of the buddings is illustrated by the data for girth increase summarised in Table XII.

TABLE XII. *Rate of Growth of Budded Trees of the Pilmoor Clones*

a.d. = Trees tapped alternate-daily.
d.a.m. = Trees tapped daily in alternate months.

Date of Measurement	Mean girth of trees in inches at height of 40 inches from union										
	A. 44		B. 58		B. 84		D. 61		B. 16		D. 65
	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.
December 1927	11.8	11.7	12.2	12.0	13.4	13.6	10.4	11.2	9.2	9.3	13.3
September 1928	15.0	15.1	15.0	14.9	17.1	17.2	12.9	13.8	12.9	12.9	16.5
December 1929	18.7	19.0	19.2	18.8	22.0	22.2	...	...	19.8	19.5	22.8
.. 1930	20.8	20.8	20.6	19.8	24.8	24.7	19.3	21.0	21.3	21.5	26.6
.. 1931	23.3	23.3	21.8	21.7	27.7	27.5	21.8	23.8	24.5	24.7	30.1
.. 1932	24.7	24.4	23.2	22.0	30.5	29.8	23.2	25.4	26.6	26.4	31.9
.. 1933	25.7	25.2	25.2	24.1	33.1	32.4	25.4	28.6	28.6	28.2	33.8

* See Annual Reports R.R.I. of Malaya 1928, p.41; 1929, p.51; 1930, p.64; 1931, p.64; 1932, p.72.

It is noteworthy that the trees of the most vigorous clones, B.84 and D.65, have shown a steady rate of girth increase but that, after the year 1929, the weaker clones, eg. A. 44 and B. 58, have increased very slowly. It is possible that the severe tapping tests to which the trees have been subjected have had a retarding effect on growth.

Yield

The progress of yield increase is shown in Table XIII. It should be emphasised that in this experiment every tree of each clone is included in the tests and that the normal commercial routine of tapping, collection and manufacture of the crop into smoked sheet is followed in every detail. The records are based on total dry rubber and include approximately 10 per cent of lower grades (lump and scrap) which is manufactured into crêpe.

TABLE XIII. *Progress of Yield of Budded Trees of a Number of Clones on Pilmoor Estate planted in November—December 1924*

Year	Average age of trees years	Yield in pounds dry rubber per tree per annum										
		A. 44		B. 58		B. 84		D. 61		B. 16		D. 65
		a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.
1928	3½	4.4	—	2.6	—	3.8	—	—	—	—	—	—
1929	4½	6.0	5.5	4.2	4.8	5.2	6.9	5.1	—	5.5	4.9	4.5
1930	5½	6.6	6.6	7.2	6.8	7.1	8.1	6.3	6.2	8.7	8.1	11.0
1931	6½	7.1	8.0	8.7	9.0	9.2	11.3	8.2	8.8	11.4	11.8	15.9
1932	7½	8.2	8.6	10.2	10.6	12.3	14.3	9.5	10.9	13.0	13.4	19.0
1933	8½	9.3	8.9	9.6	10.8	15.9	18.5	7.1	10.0	15.1	17.3	20.0

It will be noted that, with the change in tapping height, the best clones have shown a marked increase in yield and even the mediocre clones have not shown a serious fall in yield. The figures also indicate the dangers of a too early selection of young clones on the results of the first tapping tests.

The difference in yield between the two groups of trees of Clone B. 84 tapped a.d. and d.a.m. has been maintained. On the new panel, Clone B. 16 shows a similar response to periodic tapping but it is noteworthy that this pronounced difference in response has been consistently

shown by Clone B. 84 over the whole period of 5 years of normal tapping.

Dry Rubber Content of the Latex

Daily determinations of the dry rubber content of the latex from the different clones and the different experimental groups of trees are made; the summarised results are given in Table XIV. For trees of this age, 8½ years, the average dry rubber content of the latex is very satisfactory for all clones and is generally higher than that recorded for seedling trees of comparable age. In this aspect of the work on budded trees the closest contact has been maintained with the Chemical Division.

TABLE XIV. *Dry Rubber Content of the Latex from Budded Trees of the Pilmoor Clones*

		Dry rubber content (per cent)										
Tapping level	Year	A.44		B.58		B.84		D.61		B.16		D.65
		a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	a.d.	d.a. m.	
Low Cut 10 to 0 ins. from union	1932	37.7	36.8	43.0	37.3	39.0	35.2	32.7	33.9	37.9	36.1	34.5
	1933	33.4	36.2	38.7	37.8	33.1	32.4	—	—	36.3	35.8	—
High Cut 40 to 32 ins. from union	1932	37.4	37.9	41.1	38.2	35.4	32.5	—	—	38.3	35.5	—
	1933	37.1	37.5	43.5	40.3	36.6	34.3	34.8	36.3	37.3	36.6	32.7

Note :—As in 1932, Clone B.58 continued to give latex with exceptionally high D.R.C.

Bark Consumption and Bark Renewal

Detailed records were given in the previous Annual Report and on the basis of these records, taken over the first four years of commercial tapping, bark consumption has been controlled from the date of opening of the new panels. The allowance of bark per tapping month has been fixed at 0.75 inch for alternate-daily tapping and 1.50 inches for daily tapping in alternate months.

Mr. H. Gunnery has carried out a detailed anatomical examination of the renewed bark of various ages from 6

months to 4 years. The detailed results will be reported separately. The investigation showed that the progress of renewal was extremely rapid in the four clones studied. At 3 years the productive layer of soft bast in the renewed bark was equal to that found in the virgin bark 8 years of age. The number of latex vessel rows also increased rapidly until at 4 years there was little difference in structure of the latex-producing zone in virgin and renewed bark.

Incidence of Disease and Losses from Mechanical Damage or Pests

In Clone B. 16 two fresh cases of brown bast appeared on trees tapped on a low panel close to the union. No other cases of disease have been observed during the year. Clone A. 44 has suffered considerably from storm damage. The irregular branching habit and heavy crowns appear to make this clone particularly susceptible to mechanical damage. In Table XV. a summary of records of disease and losses from other causes is given. Trees affected with brown bast are rested immediately the trouble is observed and, after a rest of one year, tapping is recommenced. If, after one year of tapping, brown bast does not reappear the tree is recorded as a recovered case.

TABLE XV. *Incidence of Disease and Losses from Pest Attack and Mechanical Damage*

Clone	Maximum No. of Trees Tapped		No. of cases of Brown Bast 1929-1933		Recoveries from Brown Bast		Storm Damage	Root disease and White ants
	a.d.	d.a.m.	a.d.	d.a.m.	a.d.	d.a.m.		
A. 44	54	54	4	4	3	all	29	9
B. 58	34	35	1	2	all	all	2	1
B. 84	18	18	1	2	all	1	1	1
B. 16	38	37	5	5	all	3	1	2
D. 61	13	12	1	3	all	all	Nil	Nil
D. 65	5	—	Nil	—	Nil	—	Nil	1

(b) *Influence of the Tapping Height on Yield of Budded Trees*

(i) The experiments described in the previous Annual Report * have been repeated. Using both systems of

* R.R.I. of Malaya Annual Report 1932. p.76-78.

tapping (a.d. and d.a.m.) comparable groups of trees have been tapped at heights of 40 inches to 32 inches and from 8 inches to the union. The results are summarised in Table XVI. The experiment was carried out from May to December 1932 and repeated from January to September 1933. The figures for both periods are summarised.

TABLE XVI. *Influence of Tapping Height on Yield of Buddings*

System of Tapping and Year of Test	Yield in grams dry rubber per tree per tapping							
	A. 44		B. 58		B. 84		B. 16	
	High	Low	High	Low	High	Low	High	Low
<i>Alt. Daily</i>								
1932	26.8	22.0	28.8	30.1	39.0	39.5	37.0	37.0
1933	26.7	22.4	23.7	33.4	42.4	39.7	41.3	41.4
<i>Daily a.m.</i>								
1932	30.8	26.7	31.9	29.5	48.0	43.6	41.2	37.1
1933	24.4	27.1	27.9	32.5	51.6	36.6	48.1	41.9

Although on the whole the figures show a higher yield from the higher tapping level, the salient feature brought out by these results is the relatively uniform yield of budded trees, whether they are tapped at a high or low level. A normal seedling tree would produce at least fifty per cent more rubber when tapped at ground level than at a height of 30 inches. The widest difference shown in the above table is considerably less than this. The detailed results, from which Table XVI has been compiled, will be more fully discussed in a later publication.

(ii) In order to obtain additional information on the influence of height of tapping on yield two further small scale experiments were commenced. In addition to the six most promising clones on Pilmoor Estate there are several clones with satisfactory, but not outstanding, yielding properties. Two of these clones have been utilised in the present tests. In Clone B. 50, fifty trees were divided as evenly as possible into five groups of ten trees each. Tapping was commenced at five different heights

from 10 inches above the union rising by intervals of 10 inches to a height of 50 inches from the union. In Clone B. 95 only twenty trees were available and tapping was carried out at heights of 20 inches and 40 inches from the union. Tapping was alternate-daily with a left to right cut at a slope of 35 degrees over half the circumference of the tree.

TABLE XVII. *Yields of Budded Trees tapped at different Tapping Levels during the first experimental Year*

Clone	Yield in grams per tree per tapping at heights of :—				
	10 inches	20 inches	30 inches	40 inches	50 inches
B. 50	18.2	16.2	14.8	14.0	12.6
B. 95	—	17.1	—	14.0	—

The results summarised in Table XVII. show that the yield of budded trees of the clones used is relatively uniform at different tapping heights in comparison with results obtained with seedling trees in similar experiments. On seedling trees the yield at ground level has been shown to be almost double that obtained at a height of 48 inches whilst the extreme difference shown in this experiment is less than 50 per cent. It should be stated that, in the present experiment, differences in the yields recorded at different heights are not directly proportional to differences in girth of the trees nor to the relative lengths of the tapping cut at different levels.

(c) *The Influence of the Direction of the Tapping Cut on the Yield of Buddings*

It has been shown in tapping of seedling trees that a tapping cut at a left to right slope gives a higher yield than one from right to left. A preliminary test on budded trees of Pilmoor Clone B. 95 gave the following result over the first year of experiment (120 tappings):

Trees tapped from right to left 10.3 grams per tapping
Trees tapped from left to right 14.0 grams per tapping

The difference is fully significant and suggests that the left to right single cut may prove to be the best form of tapping cut to employ on budded trees. The experiment will be repeated on a number of different clones.

(d) *Tests of Economic Tapping Systems on Budded Trees*

In view of the interest in "double-cut" tapping systems on seedling trees preliminary tests have been carried out on buddings of four clones.

Clone B. 95. Three groups of 10 trees each, have been tapped as follows:

Group (i) Single right to left cut at 40 inches

" (ii) Single left to right cut at 20 inches

" (iii) Two cuts combining (i) and (ii) on opposite sides of the tree.

All tapping cuts are over half-circumference at a slope of 35 degrees.

In groups (i) and (ii) the trees were tapped alternate daily for one year, in group (iii) alternate-daily tapping was carried out for two periods of three months with intervals of three months rest between tapping periods.

Clones D. 29, B. 65, and C. 94 have been utilised in a similar manner to compare the yields obtained by short periods of double-cut tapping, daily for 15 days, with periods of six weeks rest and tapping single cuts daily, in alternate months.

In the summary of the main results, presented in Table XVIII. the average yield per tree on the single cut tapping systems is compared with that of trees tapped on the double-cut system.

TABLE XVIII. *The Yields of Budded Trees on Single and Double-cut Tapping Systems*

System of Tapping	Average yield per tree in grams dry rubber per tapping			
	Clone B. 95	Clone C. 94	Clone B. 65	Clone D. 29
Single tapping cut on half circumference	13.7	20.7	20.6	16.6
Two cuts on opposite panels both on half circumference	30.7	34.2	38.1	30.3

In comparing the relative total yields on the two systems of tapping it should be remembered that the trees on the two-cut systems are tapped on half as many occasions as the trees on single-cut systems so that in order to obtain a comparison of the actual yields, the figures for the single-cut systems should be doubled.

Compared on this basis these preliminary tests, conducted over one year, show that in Clone B. 95, (trees tapped alternate-daily with single cuts compared with trees tapped alternate-daily with double cuts for two periods of three months) the relative yields are 100 to 112. In the remaining clones (daily, alternate-monthly tapping on single cuts compared with daily tapping on double-cuts with periods of 15 days tapping and 45 days rest) the relationships are in C. 94, 100 to 82.5; in B. 65, 100 to 92.4; and in D. 29, 100 to 91.3.

If these figures are compared with those obtained by the use of double-cut tapping systems on seedling trees it will be noted that all the clones tested show a much more favourable return from double-cut tapping than seedling trees. The very favourable result obtained with Clone B. 95, suggests that the alternate-daily systems of tapping on double-cuts with long rest periods may prove valuable in practice.

Other interesting observations have been made in the course of these experiments; in particular the influence of a low cut on one side of the tree on the yield of a higher cut on the opposite side of the tree has been studied. Latex was collected separately from upper and lower cuts on the trees tapped on the double-cut system. In all clones the upper cut on the 'two-cut' trees gave a lower yield than a cut at a corresponding height on single-cut trees. On the other hand, there was a strong indication that the yield of the lower cut on the 'double-cut' trees was greater than that obtained from trees tapped at the same height with a single cut.

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(c) *The influence of different Tapping Systems on the Yields of Buddings*

The experiments in progress on Clone Glenshiel No. 1 described in previous Annual Reports, have been continued during 1933. Towards the end of 1932 the original tapping panels opened in January 1930, at a height of 36 inches,

were completed to within a few inches of the union and by the beginning of 1933 in all groups new panels had been opened at the appropriate heights on the opposite side of the tree. In all trees the new tapping cut was immediately above the renewed bark of a previous panel opened in April 1928 at a height of 30 inches from the union. The relative yields of the most important groups of trees are given in Table XIX.

TABLE XIX. *Yields of Buddings of Clone Glenshiel 1 on different Systems of Tapping*

Group	No. of Trees	System of Tapping	Yield in grams per tree per tapping		Yield expressed as percentage of yield of Group 1	
			1932	1933	1932	1933
I	20	Single cut on half-circ. left to right Alternate-daily	63.1	73.5	100	100
A	18	As I; tapped when I is resting	57.0	70.2	90	96
III	20	As I; tapped daily in alternate fortnights	54.1	72.1	86	98
IV	20	Heusser System. Two quarter-cuts at 40 and 80 inches Alt.-daily	67.0	80.0	106	109
V	20	Single cut on one-third circ. Alternate-daily	55.1	55.7	87	76
VI	20	As V but tapped daily in alternate fortnights	51.9	62.6	82	85

In Table XIX the mean yield figures are based on 10 months' tapping in all groups except Groups I and V which were tapped over the whole year.

The reason for this was a very marked and progressive decrease in yield which occurred in all groups of trees as the tapping cuts approached the line of division between virgin bark and the renewed bark at a height of 30 inches on the 1928 tapping panel. In the trees tapped on the Heusser system the lower cut was approaching the renewed bark of the original tapping panel on a single half-circumference cut opened in January 1930.

The progress of yield is illustrated by the figures given in Table XX.

TABLE XX. *Progress of Yield in Clone Glenshiel I as the Tapping Cut approaches the Region of Union between Virgin and Renewed Bark*

Group	Mean yield per tree in grams dry rubber per tapping												Mean Yield grams.
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
I	94.1	91.3	82.9	98.8	89.0	82.3	71.5	64.5	55.0	46.1	50.8	55.8	73.5
I A	86.3	79.0	66.6	74.0	74.7	76.0	67.5	68.0	60.2	49.9	...	...	70.2
III	90.8	81.0	66.6	72.3	74.6	80.3	73.6	70.9	55.8	55.4	...	...	72.1
IV													
Upper Cut	42.3	43.3	41.0	49.2	50.0	49.2	41.6	42.3	42.6	...	...	...	43.9
Lower Cut	42.9	43.2	34.7	41.2	43.6	40.1	33.8	30.2	25.2	...	...	...	36.1
V	62.3	65.2	56.6	67.3	65.6	65.0	61.8	55.2	44.3	39.5	42.3	43.8	55.7
VI	71.5	73.0	57.8	71.5	67.2	67.6	63.6	63.6	45.4	45.0	...	...	62.6

In groups I and V, tapping was continued and by the end of the year the lowest point of the new tapping cut had just reached the renewed bark of the old panel which had been tapped with a much smaller angle of slope. It will be noted that, after October, yields began to rise again. The reasons for these fluctuations in yield are being studied; anatomical investigations of bark structure and continuity of latex vessels in virgin and renewed bark have contributed little evidence to account for the observations so far. Whether the observed phenomenon is a peculiarity

of the clone will be studied as soon as comparable tests can be carried out on budded trees of other clones.

We must again express our indebtedness to Mr. J. H. H. Baillie and Mr. W. A. D. Wynch for their continued interest in the progress of this work on Glenshiel Estate.

C. E. T. Mann & H. Gunnery

(f) *Yields of young Buddings (Second vegetative Generation) from old established Clones*

The tests in progress on Pilmoor Estate on young buddings of Clones A. 44 and B. 84, made in April 1928 from the original budded trees, have been continued. The summary of the records for the test-tapping year and the first 6 months of commercial tapping are given in Table XXI. Test-tapping was carried out alternate-daily in alternate months for one year and a new panel was opened at a height of 40 inches from the union and tapped alternate-daily on half-circumference of the tree during the first period of regular commercial tapping.

TABLE XXI. *Relative Yields of 1st and 2nd vegetative Generations of Buddings of Clones A.44 & B.84*

Clone	Test - Tapping				Commercial tapping (6 months)			
	1st. Generation		2nd. Generation		1st. Generation		2nd. Generation	
	Girth at 20 ins.	Yield per tree per tap- ping	Girth at 20 ins.	Yield per tree per tap- ping	Girth at 20 ins.	Yield per tree per tap- ping	Girth at 20 ins.	Yield per tree per tap- ping
	ins.	gm.	ins.	gm.	ins.	gm.	ins.	gm.
A. 44	14.3	12.6	14.7	11.8	19.0	17.7	19.4	23.0
B. 84	15.4	10.8	14.3	6.4	22.0	13.8	20.7	13.7

The young buddings appear to be reproducing very closely the characteristics of the original buddings. Clone A. 44 gives an exceptionally high yield when young. Clone B. 84 shows a much more gradual rate of yield increase.

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(3) ANATOMICAL STUDIES

In order to reach a proper understanding of the complex physiological processes concerned in the formation of latex it is essential to obtain a detailed knowledge of the structure of the tissues in which the latex is produced. Early studies of the structure of the latex vessels and their distribution only take us a part of the way; a more intimate knowledge is required not only of the latex vessels themselves but of the other important tissues with which the latex vessels are associated and from which they obtain the supplies of raw materials for the synthesis of latex. The studies described in this section are directed towards this end.

(a) *Bark Structure in Hevea with special Reference to the Sieve Tubes*

The sieve tube system constitutes the main channel for the transportation of elaborated food materials. It is in intimate anatomical contact with the latex vessel system in the bark and with the water-conducting vessels of the wood through the agency of innumerable radially disposed plates of tissue known as the medullary rays. It is desirable to appreciate the essential unity of this conducting system in relation to the problem of latex synthesis.

The sieve tubes were first studied in young bark of clonal material and were there observed to form a distinctive band or zone, encircling the wood and separated from it only by the thin line of the cambium. The radial width of the zone measured from 0.75 to 1.5 mm. The individual cells or tubes were of relatively enormous size closely aggregated between the medullary rays. Here then, was a highly developed translocatory system associated with high yield and the question at once arose whether the character was constant for all high-yielding trees, and absent or poorly developed in low yielders.

To obtain further light on the problem, the bark of budded trees of thirty established clones was examined and found to be in general agreement for this character although the intensity of development varied from clone to clone. The investigation was then extended to a block of five years old seedlings which had been test-tapped and recorded over a period of two years. Samples of bark were collected from 40 trees of consistently low-yielding

record and 40 from the highest yielders. Here again the sieve tube structure of high yielders agreed in all respects with the clonal material, whereas in the low yielders, the sieve tubes were poorly developed throughout the whole series and in some cases could not be clearly identified. A survey of all available test-tapped material has been commenced and corroborative bio-chemical data will be sought for by direct physiological experiment. It would be premature to attempt to formulate any definite conclusion at the present stage of the investigation.

H. Gunnery

(b) *Bark Regeneration*

The anatomical history of bark regeneration from the most recent tapping cut to the fourth year of renewal has been worked out.

It has been demonstrated that the earlier activities are associated mainly with the need for protecting the delicate tissues of the soft bast exposed at tapping. This is accomplished very rapidly by the formation of a protective skin from the superficial cells and the impregnation of the whole tissues with a substance analogous to the wound gum characteristic of woody tissues, after wounding. The question of their chemical identity awaits further analysis. They agree in staining reaction and resistance to de-staining solutions; in their insolubility in a wide range of reagents and in their reduction by mixtures of chromic and nitric acids.

With the defensive armour completed, the cambium resumes activity, and concurrently the distal ends of the medullary rays enlarge and divide tangentially. The divisions extend subsequently across the intervening medullary gaps to form a continuous meristematic layer parallel to, and in close proximity to the outer surface. This secondary cambium (phellogen), by continual tangential divisions, is responsible for the development of the mechanical tissues of the bark, the corky, true bark to the outside and the characteristic masses of stone cells from its inner face. From the cambium itself is derived the tissues of the soft bast, sieve tubes, latex vessels and small groups of stone cells, all of which are embedded in a smaller-celled ground tissue, the phloem parenchyma. By the end of the fourth year, and in some examples somewhat

earlier, the full complement of latex tube rings characteristic of the virgin bark is fully restored. It must not be assumed, however, that the renewed bark at this stage is exactly comparable to virgin bark. In the first place, the proportion of non-productive (mechanical) tissue to latex tissue is much higher in virgin bark and this will probably be reflected in the greater ease with which such bark can be tapped. Moreover, the stone cells in such bark are differentiated from groups of fully developed cortical cells more or less fortuitously, whereas in renewed bark they take their origin from predetermined "islands" of meristematic cells derived from the phellogen and also to a smaller extent from the cambium itself.

H. Gunnery

III. Selection and Breeding

¶1) SELECTION OF HIGH-YIELDING TREES ON ESTATES AND THE ESTABLISHMENT OF NEW CLONES

The establishment of all clones from parent trees selected on estates has been completed. On the R.R.I. Experiment Station (Block 15) 235 new clones have been planted, with clone A.V.R.O.S. 50 as the standard clone, for comparative tests at a later stage. In addition, 55 clones of historic interest from Sumatra and Java, together with newer Malayan clones, of which little is known at present, have been planted in the same block.

C. C. T. Sharp

¶2) ARTIFICIAL POLLINATION AND BREEDING

Work has been limited to the completion of budding of new clones derived from seedlings obtained by artificial pollination between high-yielding clones.

The oldest crosses made in the flowering season of 1928, were planted between April and June 1929 and on these a preliminary tapping test was carried out in July 1933. All trees in the experimental plot (Block 4A, R.R.I. Experiment Station) having a girth of 18 inches or more at a height of 20 inches from ground level were tapped alternate-daily for one month with a single left to right cut over half circumference. Certain families, considering that the trees were only four years of age,

have given very promising yields. An extract of the results is given in Table XXII. Interplanted with the legitimate crosses are illegitimate seedlings of the parent trees and a number of these were tapped for comparison with the crosses.

TABLE XXII. *Results of Test-tapping of legitimate and illegitimate seedlings derived from high-yielding Parents*

Origin of Seedlings	No. of trees Tapped	Yield in grams per tree per tapping.			Coefficient of Variability as percentage
		Best Tree	Poorest Tree	Average all trees	
A. 44 x B. 58	4	9.1	5.5	7.2	—
A. 44 x D. 61	16	9.2	1.5	4.6	44.8
A. 44 x B. 16	10	6.7	3.1	4.5	25.3
D. 61 x A. 44	19	13.8	1.7	5.5	53.2
B. 95 x A. 44	5	16.6	2.4	6.6	—
A. 44 (Illegitimate)	70	22.7	0.8	4.8	81.7
B. 58 (" ")	34	7.0	0.1	3.9	67.1
B. 95 (" ")	6	2.6	0.5	1.7	—
Common Seedlings	116	15.8	0.2	3.1	—

The yields on the whole are considerably higher than those obtained from normal, common seedlings at comparable age. (In the table the yield of common seedlings is taken from a parallel experiment in progress on a mixed seedling population on an adjoining block). The second point of interest is the relatively smaller degree of variation between the members of the legitimate families as compared with illegitimate seedlings where only the origin of the mother tree is known. The average yields of all the seedlings derived from high-yielding clones are considerably better than the yields of seedlings of common origin. Clone B.95 was chosen as a parent on account of its excellent growth and good bark characters. Crossed with A.44, a clone with high yield but poor secondary characters, it has given seedlings of excellent appearance and good yielding properties. It will be noted that the illegitimate seedlings of clone B.95 all give poor yields whilst the illegitimate seedlings of clone A.44 are considerably above the average.

(3) STUDY OF SEEDLINGS DERIVED FROM HIGH-YIELDING CLONES

(i) A first series of tapping tests was carried out on seedlings grown from natural seed, i.e. seed picked from the trees without any attempt to control pollination, from budded trees of clones A.44, D.61 and from an individual mother tree, probably one of the oldest trees in Malaya, growing in the Residency grounds at Kuala Kangsar. The method of testing was the same as that used in the tests on legitimate and illegitimate seedlings described in the preceding section. The trees were planted in December 1928 and were $4\frac{1}{2}$ years old at the time of testing.

TABLE XXIII. *Yields of Seedlings derived from Budded Trees of high-yielding Clones*

Origin. (Mother tree)	No. of seedlings tested	Yield in grams per tree per tapping			Coeffi- cient of variabi- lity as percent- age
		Best tree	Poorest tree	Mean of all trees	
Clone A. 44 (a)	19	20.2	1.3	5.9	79.0
(b)	35	17.5	1.3	5.9	62.0
(c)	17	15.5	1.3	6.5	64.7
Clone D. 61	45	6.0	0.6	2.6	52.4
Kuala Kangsar Seedling	35	4.9	0.3	2.0	58.8

For Clone A.44, seed was collected from three bud-
dings (a) (b) and (c) which were being test-tapped for the
first time in 1928. The relatively uniform yields of the
three groups of trees is interesting. This preliminary test
indicates that the illegitimate seedlings of certain clones
may be capable of high average yields but that the varia-
tion in yield will be considerable.

(ii) Seedlings were obtained early in the year from an
isolated seed garden on Batu Kawan Estate, Province
Wellesley. The garden is planted with seven proved
clones and two clones derived from the two highest yield-
ing parent trees on the estate. The proved clones

include A.V.R.O.S. 49 and 256, Prang Besar 23 and 186, Tjirandji 1 and Bodjong Datar 5 and the valuable parent clone, A.V.R.O.S. 157. Permanent plots were established on the R.R.I. Experiment Station with this material in November 1933. We are indebted to the Directors and Mr. G. S. Reis, the manager, of Batu Kawan Estate for supplying this material.

(iii) The budded trees in the Clone Trial Block (R.R.I. Experiment Station, Block 5.) set seed for the first time in 1933 and seed collected from individual trees has been planted in permanent plots for future study.

(iv) Purchases of clonal seed from large monoclonal plantings of well-known proved clones have been made.

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(4) TEST-TAPPING METHODS AND THEIR VALUE IN SELECTION AND FOR THINNING IN SEEDLING PLANTATIONS.

The investigation of test-tapping of seedling trees on the seedling collection plot (R.R.I. Experiment Station Block 2) has been continued. The chief aims of this investigation are:—

- (i) To re-examine the generally accepted belief that good yielders remain good and poor yielders remain poor.
- (ii) By careful statistical examination of the detailed records of individual tree yield to discover the minimum amount of tapping and recording necessary for reliable elimination of unprofitable trees and the earliest age at which test-tapping will give a reliable indication of future yield.

The experiment was initiated in January 1932 when the trees were $3\frac{1}{4}$ years of age and, so far, four tests have been carried out at intervals of 6 months. Three methods of tapping are being tested. In order to follow changes in position the yields of each tree in successive periods have been correlated. (Table XXIV).

The coefficients of correlation obtained are remarkably high and show clearly that the best trees are maintaining their superiority and the yields of the worst trees are not improving materially. Exceptions do occur but in almost

TABLE XXIV. *Correlation between Yields of Seedling Trees in successive Tapping Periods*

Group and System of tapping (All cuts on $\frac{1}{2}$ circ)	Coefficient of correlation between individual yields in the first period and yield in the:-		
	2nd. period	3rd. Period	4th. Period
I. Tapped Daily for 30 days	+ 0.90	+0.88	+0.98
II. „ A.D. for 30 days	+ 0.93	+0.82	+0.77
III. „ Daily for 15 days	+ 0.91	+0.75	+ 0.88

every instance trees showing divergence from the general progress of yield increase have been affected by disease, chiefly *Fomes lignosus*, or have suffered mechanical damage in storms.

The detailed daily records of yield have been examined to test the value of shorter periods of test-tapping as an index of yield value. The total yield for the 6th. to 10th. tappings, 5 tapping days in all, has been correlated with the yield obtained for the whole period of test. The results summarised in Table XXV. show that the degree of correlation is practically perfect and therefore the short test period provides a reliable index of the individual value of the trees.

TABLE XXV. *Correlation between Yield for five Tapping Days and the Yield over the whole Test Period*

Group and System of Tapping	1st Period	2nd Period	3rd Period	4th Period
I. Daily 30 days	+ 0.92	+0.94	+0.95	+ 0.96
II. A. D. 30 days	+ 0.97	+ 0.99	+ 0.97	+0.99
III. Daily 15 days	+ 0.99	+ 0.98	+ 0.96	+0.99

The close agreement between the short and long period tests and the yields in successive tests support the view that a short period of test-tapping at an early age, may provide a reliable index of the relative values of seedling trees. The experiment will be continued for several years in order to compare mature yields with those obtained by test-tapping.

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IV. Natural Cover Plants in Rubber Areas

(i) The systematic botanical work in connection with the development of the so-called "forestry" system of rubber cultivation has increased considerably. Plants from estates in all parts of the country have been forwarded for identification and, although the work is to a great extent purely advisory work carried out in collaboration with the Soils Division, it has occupied a large proportion of the time of the Assistant Botanist. The work involves a careful study of the characters of the numerous natural orders to which belong the plants of most common occurrence in the regenerating natural flora of cultivated areas. The range of species represented is very wide but members of certain natural orders appear to play a dominant part in the process of repopulation of cleared areas.

The work of the past two years has convinced us that there is little to be gained from a detailed identification and precise study of individual species. What is required is a broad classification of plant types based on characteristics of habit of growth and response to the treatments necessary to maintain effective control. For example, conditions which favour the development of fungus diseases of the tapping panel and prevent rapid observation and inspection of the trees must be avoided. The ground flora must be controlled therefore, and slashing or pollarding is necessary. Many plants will not tolerate repeated pruning so that it is clear that selection of species before they have reached the stage when control becomes necessary may be wasted effort. It is not until a satisfactory cover of shade-tolerant plants, which will withstand repeated pruning, has been obtained that careful selection of species is likely to prove of value.

(ii) Experimental work on this subject has been continued in the Lake Gardens Experimental Area and on the R.R.I. Experiment Station during the year. Detailed plans have been prepared for the development of new areas on the Experiment Station in which the natural flora will be retained. In the isolated plots, in the Sungei Buloh Forest Reserve, observations are being continued.

We are greatly indebted to Mr. R. E. Holtum, Director of Gardens, S.S. and his staff for their generous assistance in the systematic botanical work in connection with these investigations.

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V. Field Experiments on the R.R.I. Experiment Station, Sungei Buloh

In the Annual Report for 1932¹ a detailed table of field experiments in progress was published. The following additional experiments have been commenced during 1933.

Block Number	Acreage	Description of Experiments in Progress ²	Date commenced
9A	2	Study of the value of clonal seed of Clone A.V.R.O.S. 157 from an isolated seed garden containing Clones A.V.R.O.S. 49 and 256, B.D. 5. Tjir. 1. P.B. 23 and 186 and two unproved clones. (Batu Kawan Estate).	Nov. 1933
18 ²	78	Tapping experiments on budded trees. Planted with the following clones for the ultimate testing of the response of different clones to different systems of tapping. Clones P. B. 25, 180, 186. Glenshiel 1. Sabrang 24. Rubana 393 S.R. 9. Pilmoor B. 84, B.D. 5. Tjir. 1 and 16. A.V.R.O.S. 49, 50, 152 and 256.	Dec. 1932

(1) Annual Report R.R.I. of Malaya 1932, p. 87-90.

(2) Omitted in error from Annual Report for 1932.

Block Number	Acreage	Description of Experiments in Progress.	Date commenced
20	22	Duo-clone planting of buddings using a density of 200 trees per acre. The following clones are being tested in pairs. The aim is to retain the best clone of each pair so that eventually monoclonal blocks will be obtained. Clones A.V.R.O.S. 49 and Lampongiana 1 Clones A.V.R.O.S. 256 and Lampongiana 2 Clones B. D. 5 and P.B. 86 Clones Tjir. 1 and P.B. 180 Clones P.B. 186 and P.B. 183 Clones Rubana 393 and Waringiana 1 Clones Sabrang 24 and Waringiana 4 Clones S.R. 9 and A.V.R.O.S. 214	April 1933
20A	3	Study of the value of clonal seed from isolated seed gardens. Seedlings from clones:— AVROS, 157, 49 and 256. B.D. 5. P.B. 23, 25 and 186. Sabrang 24.	Nov. 1933

VI. Advisory Work

CORRESPONDENCE

A detailed analysis of the advisory work dealt with by correspondence will be found in the appendix to the report of the Director. The volume of correspondence has shown a considerable reduction; the enquiries dealt with numbered 700 as compared with 1200 in 1932. This reduction is mainly accounted for by the smaller number of enquiries on budding. Since the development of new areas has been extremely small since 1930 and the budded areas already established are now in the stage when they require little further attention until tapping commences, the apparent falling-off in interest is easily understood.

The completion of the work in connection with the selection of mother trees on estates has also reduced the amount of routine correspondence considerably.

Tapping problems have been the chief subject of correspondence during the year under review. Approximately one half of the enquiries received on the subject of tapping have concerned the test-tapping of densely-planted seedling areas and the methods of tapping of budded trees.

In the course of advisory work it has been possible to assist the managers of a number of estates in the planning of experiments and to give assistance in the weighing of samples and recording of yields of experimental areas. We have found it possible by this means to supplement in a valuable manner our own experimental work but staff facilities at the laboratory naturally limit the extent to which we can avail ourselves of the opportunities afforded.

ESTATE VISITS

A summary of estate visits, including visits paid in connection with experimental work is presented.

<i>Member of Staff</i>	<i>Nature of Visit</i>	
	<i>Advisory</i>	<i>Research</i>
C. E. T. Mann	... 76	77
C. C. T. Sharp	... 6	149
H. Gunnery	... 1	8
K. N. Kaimal	... 1	70
	—	—
	84	304
	—	—

The large increase in the number of visits paid in connection with research work is accounted for by the rapid development of work on the Experiment Station and on the Seventh Mile and other estates in the conduct of tapping experiments.

INTERVIEWS AND VISITORS

During the year 90 interviews were arranged with members of the Division by estate managers and others. The subjects discussed included budding and choice of clones 28; tapping problems 38; natural covers in old rubber areas 35.

(4) LECTURES

The following lectures were delivered by the head of the division:

- (1) Malacca District Planters' Association on February 5th. 1933 on "Tapping Systems."
- (2) Central Perak Planters' Association on April 29th. 1933 on "Yields of Modern Rubber Plantations."
- (3) Annual Conference of the Incorporated Society of Planters at Taiping on August 18th. 1933. "Some Aspects of Economic Production."

VII. Publications

- (1) "The History and Description of Clones of *Hevea brasiliensis*" C. E. T. Mann and C. C. T. Sharp. Illustrated by H. C. Chuan.
R.R.I. of Malaya. Planting Manual No. 5
- (2) "Yields of Modern Rubber Plantations" by C. E. T. Mann.
The Planter Vol. 13. No. 12
- (3) "Some Aspects of Economic Production" by C. E. T. Mann.
The Planter Vol. 14. No. 2

C. E. T. MANN
Head of Botanical Division.

ANNUAL REPORT

PATHOLOGICAL DIVISION

Staff

At the beginning of the year Mr. F. Beeley continued as Acting Head of the Division in place of Mr. A. Sharples who was Acting Director. On the return from home leave of the Director, Mr. Sharples reverted to his substantive post as Head of the Pathological Division on the 18th February. Mr. Beeley and Mr. R. P. N. Napper continued their services as Pathologists throughout the year.

It is pleasing to record herein our appreciation of the services of Mr. Choo Kok Leong, B.A. (Oxon) who has assisted the Division in an honorary capacity since February 1933. We are also indebted to the Asiatic junior staff for the valuable assistance they have given throughout the year.

The staff now comprises three European officers viz. the Head of the Division and two Pathologists.

Research

The main lines of research have been continued from last year and it can safely be said that the year's work has resulted in considerable progress being made. Our knowledge in respect of the problem of root diseases has resulted in a very definite change of ideas. Further information has been also obtained in relation to the leaf disease caused by the fungus *Oidium Heveae*. Work on White Ants has resulted in a better knowledge of their mode of attack and treatment. A new record of an insect pest on young rubber plants has been made. The latter is the caterpillar of *Thosea sinensis* Walk. which has been found feeding on rubber leaves.

ROOT DISEASE INVESTIGATIONS

The progressive undermining of classical root disease theories, which had marked the course of these investigations in earlier years,* culminated, during the year, in a complete revolution in outlook on the root disease situation as a whole.

*See Annual Reports for 1931 and 1932, and Journal of the R.R.I. Vol 4, No. 1, pp. 5—33, July 1932.

This revolution in outlook was brought about by the discoveries:—

(a) that *Fomes lignosus*, *Ganoderma pseudoferreum* and *Fomes noxius*, the three common root disease organisms of the rubber tree in this country, employ identical methods of root parasitism, each fungus using as its weapon of attack a specialized organ of vegetative propagation which corresponds in function to, and in each case may reasonably be described as a rhizomorph system, and

(b) that the diseases caused by these three organisms are the sole constituents of the normal root disease complex on Malayan rubber plantations (see note on "Other Root Diseases" at end of this report), followed by the logical deductions:—

(c) that normal root disease phenomena on the rubber tree in this country, though caused by a plurality of organisms, are nevertheless all of a clearly-cut standard type, each individual phenomenon being some particular manifestation of the special method of parasitism which characterizes these organisms as a group, and

(d) that direct study of this method of parasitism in general (a research problem which should not present any serious difficulties) should lead quickly and automatically to the solution of all root disease problems on rubber estates in Malaya.

These conceptions upset all preconceived ideas regarding root diseases and their control, and led to the abandonment of previous theories in favour of a single, simple theory, of revolutionary design, which seeks to explain root disease phenomena on the rubber tree in this country solely in terms of the characteristics of rhizomorphic root parasitism.

During the latter half of the year a provisional theory of this type was formulated, and applied to the solution of numerous complicated field problems with every appearance of success.

NOTES ON THE NEW THEORY

A detailed description of the new theory would be out of place in an annual report, but, as it may not be possible to publish the results in full for some time, the following brief notes are appended.

Root diseases of the rubber tree in Malaya are a direct legacy from the original jungle stand. They are caused by fungal root parasites which have evolved a special method of propagation particularly suited to their normal habit of life as subterranean parasites in a forest environment. The organ involved is the rhizomorph, a powerful weapon of propagation for such fungi,

since it enables them to produce, under favourable conditions, an endless succession of vegetative generations without the long delays (and, with their subterranean habit, difficulties) attendant on propagation by means of fruit bodies and spores. In these fungi, therefore, the vegetative method has supplanted the sexual method in importance, and the diseases which they cause consequently follow parallel courses, governed by the characteristics of rhizomorphic propagation, but practically uninfluenced by the taxonomic identity of the particular parasites concerned.

The root disease fungi follow a simple three-phase life cycle. The first phase is the invasion of the roots of a fresh host, or healthy sections of the root system of an old host, by rhizomorphs produced from infected tissue in an advanced stage of decay. The second phase is the penetration of the newly-invaded root sections, and the gradual spread of the mycelium towards the centre until the section is dead. The third phase is the production of rhizomorphs from the section when an advanced stage of decay has been reached, thus completing the life cycle. In nature the process is more or less continuous. Infection progresses in a steady wave, the advancing column of rhizomorphs being the sum of the contributions from numerous successive cycles at small phase intervals.

The production of rhizomorphs from infected tissue is probably a reaction to starvation conditions, the stimulus to production being brought into play when the fungus has completely gutted its host of all available food material and, although continuing to inhabit the empty skeleton, is forced to draw upon its own reserves for the necessities of life. Rhizomorphs are never produced from newly-infected tissue where there is ample food material available for the nourishment of the fungus. Note here the close analogy with fruit body formation.

Penetration of a host is independent of mechanical wounds. It is brought about by hyphae produced at the surface of contact of rhizomorph and host, these hyphae being able to penetrate readily through healthy bark. In fact there is some evidence to show that it is more difficult, perhaps impossible, for penetration to take place through wounds, since wounds soon become septic, and the rhizomorphs are easily destroyed by moulds and bacteria.

Being so advantageously equipped for life under forest conditions the root parasites have become generally distributed throughout the jungle. Since, however, they are normal members of the jungle association they do no spectacular destruction among the jungle trees, but here and there, like any other species, they become locally dominant, each particular parasite forming its own

pattern of root disease patches scattered throughout the jungle stand.

While the jungle is growing undisturbed these patterns are perpetually changing in shape and position, but the total incidence of infection remains constant, and the loss of stand never becomes serious.

Following felling and burning the root parasites are threatened at first with total destruction. The rhizomorphs are unable to use any but living plants as hosts, and the artificial destruction of all living hosts therefore breaks the life cycle at the end of the rhizomorph-producing phase and renders further reproduction impossible. In consequence, the sources of infection begin to exhaust themselves in futile rhizomorph production, and are doomed to disappear altogether unless a new generation of susceptible hosts is planted or allowed to regenerate in the clearing. [Note:—This explains the absence of root disease on land which has been planted previously over long periods of years with crops like sugar-cane and padi and, also the small amount of root diseases to be found in the typical small-holding.]

If, however, a woody susceptible crop like the rubber tree is established in the clearing, the threat of extinction never becomes operative. The broken life cycle is repaired, infection being transferred from the root systems of the old jungle stand to the new stand of crop plants.

The attack of root disease in a rubber plantation develops in two well-defined stages. The first stage is spread over the first four or five years after planting, while the root systems of the young plants are expanding to fill their respective planting sites. Where a site happens to contain rotten infected jungle roots, infection and death of the occupant is bound to occur sooner or later during these early years. This first stage manifests itself, therefore, as the gradual infection and death of patches of trees in the young stand, the ultimate limits of the patches coinciding with the limits of the original patches of jungle infection. The second stage of attack begins as soon as the root systems of adjacent trees are firmly interlaced. When this stage is reached spread of infection beyond the limits of the patches of jungle infection can begin, giving rise to the expanding disease patches so typical of mature stands. This second stage is far more dangerous than the first and, unless controlled, there is nothing to prevent the patches expanding until the whole planted area is involved and the whole stand destroyed.

The familiar changes in the relative dominancy of the different diseases with increase in age of the plantation can be explained

quite simply by reference to the individual characteristics (e.g. vigour and rate of growth) of the respective causal organisms concerned.

The type and rate of development of a root disease attack in a plantation varies with factors such as type of ground cover, planting density, type of soil, type of mechanical cultivation adopted, lie of the land, and so on. Brief reference may be made to the first of these factors, which happens to be of considerable topical interest at the present time.

The effect of the density of the ground cover on the rate of progress of root disease is very pronounced. The rate is highest in orthodox (i.e. wide-planted, clean-weeded) plantations, and decreases rapidly the closer the conditions of planting approximate to a forest environment. This state of affairs, however, is regulated entirely by the characteristics of the root parasites themselves, and is in no wise due (as seems to be imagined in some quarters) to any inherent virtue of the "forestry method." The rate of spread is highest in a clean-weeded stand because, in such an area, the trees are connected together by simple systems of large, straight, main lateral roots, along which the rhizomorph systems can travel without hindrance and with considerable momentum. The introduction of a ground cover however, has a braking effect on the movement of the rhizomorphs, since it introduces innumerable foreign root systems into the soil, increasing the area of root surface which the rhizomorphs have to cover in moving through unit distance in a straight line, side-tracking the rhizomorphs, and greatly reducing their collective vigour by breaking them up into small units. With the exception of grass (to the roots of which rhizomorphs will not adhere) all types of ground cover, including rubber seedlings, have this "baffling" effect, and the denser and more varied the cover the greater the effect will be. Covers alone, however, without the aid of mechanical cultivation, cannot eliminate root diseases altogether. They merely tend to reduce the incidence of root disease to proportions comparable with the incidence in virgin jungle.

Control Measures

New practical control measures, details of which will be published later, have been devised to meet the requirements of the new theory. They are planned to exploit the weak points or limitations of the rhizomorphic method of propagation, the chief of which are:—

- (i) rhizomorphs are very sensitive to desiccation;

(ii) rhizomorphs cannot grow (except under special conditions, and for short distances only) directly through the soil, but require as a vehicle a chain of solid surfaces, preferably the surfaces of roots;

(iii) although rhizomorphs can employ the surfaces of dead roots as a vehicle, they do not appear to be able to enter into and obtain nourishment from a root already colonized by other organisms;

(iv) rhizomorph systems rapidly lose their vigour and potency when split up into a large number of small units.

Nomenclature

In order to accord with the new outlook it became necessary to discard the miscellaneous collection of names applied to the three common root diseases in the past and to re-name them according to a definite system. The names finally chosen were those given in paragraph (b) at the beginning of this report.

These names are appropriate since they emphasize the close family relationship which is now known to exist between these diseases, and point to the only real source of difference between them, viz. the individuality of the different causal organisms concerned, as expressed most obviously and fittingly in the colour of their respective rhizomorph systems. Incidentally the adoption of these new names has the added advantage that it brings Malayan nomenclature into line with that in general use in Netherlands India.

Wider Applications of the new Theory

In the foregoing notes it has been emphasized that the observations made and the conclusions drawn are intended to refer solely to rubber plantations in this country.

It is possible, however, that the new theory may have wider applications, for root disease of the type under consideration occurs on other crops, and in other countries, while the literature suggests that the ability to cause this type of disease is also shared by other organisms.

The applications of the theory may be universal, for the type of parasitism which it attempts to explain can be regarded as a typical evolutionary product of the forest environment, and may have developed to a greater or lesser extent in all the natural forest areas throughout the world. The rubber tree root parasites in Malaya may be merely the local representatives, therefore, of

a group of parasites of world-wide distribution, in each member of which the same peculiar method of parasitism has been evolved. Such parasites would be expected to be more common, and economically more important, in tropical rain forest regions, where optimum conditions exist for the evolution of vegetative means of propagation, and where the planting of woody crops on land newly cleared of primeval forest is carried out on such a vast scale.

These possibilities will be discussed in detail in a future publication.

Other Root Diseases

The omission of any reference to *Ustulina zonata* and *Sphacrostilbe repens* from the foregoing discussion of root disease organisms found on the rubber tree in this country, is due to reasons which need not be discussed here.

R. P. N. Napper

LIGHTNING DAMAGE

It is only during the last few years that the extensive damage done by lightning in rubber plantations of all ages has been realised. As long as the symptoms are recognised early and measures to counteract the damage done are put in hand at once, there is not likely to be a large permanent loss of stand, as judged by our experience to date. If however there is any delay in dealing with this particular trouble, a large number of trees may be lost. A description of symptoms in both old and young trees is given in an article published in the Journal of the Institute, Vol. 5. No. 1, Sept. 1933.

MARASMIUS PANEL DISEASE

This disease was described by Thompson in the Malayan Agricultural Journal, Vol. XII in 1924, and by Beeley in 1929 under the heading "White Fan Blight" in the Institute Journal, Vol. 1 p. 265, but was reported to be doing little damage.

Recently, (June 1933) outbreaks of this disease were reported from two estates and there cannot be the least doubt that, under certain conditions, the fungus is actively parasitic, rotting the bark and cortical tissues of the newly-tapped surface down to the wood.

The first sign of attack is the appearance of a small fan of white mycelium, $\frac{1}{2}$ — $\frac{3}{4}$ inch, above the tapping cut, later forming a small plate of white mycelium, with a white mycelial fan at the

edges. A number of these plates may be formed; they are commonly found in one or all of the corners of the tapping panel. Later some of these plates may fuse together into several patches which may be from 6 to 8 inches in diameter. In the 1933 outbreak the whole of the tapped surfaces were covered with fine silky strands of mycelium, giving in advanced cases a silvery white, external appearance. The mycelial plates and strands resemble those produced by a species of *Marasmius* and recently fructifications have been successfully developed in the laboratory which confirm this view. It is almost certain that the fungus is *Marasmius palmivorus*, Sharples, a fungus common on coconut and oil palm.

A. Sharples

MOULDY ROT

The prevalence of this disease during the year, especially in areas where various indigenous cover plants have been allowed to grow, has led to considerable interest being shown by estate managers in new aspects of "Forestry" methods of cultivation. It is almost impossible to supervise pest and disease work among high cover plants while the covers themselves create an environment conducive to heavy attacks of bark diseases. Planters are now realising that, if the usual control methods fail, as has been the case with Mouldy Rot control this year, then, since it is fatal to use stronger fungicides on living bark, one must necessarily eliminate the factors contributing to this condition, i.e. the high cover plants. In districts known to be susceptible to this disease it is advisable to maintain as low-growing a cover as possible, while an area round individual trees should be clean-weeded for a distance of four feet from the base.

Many experiments conducted during the year have proved the great advantage of painting the tapping panel with water-miscible fungicides every tapping day when attempting to control Mouldy Rot. Under typical closely-planted, grass-covered, small-holding conditions it has been shown repeatedly that complete control of the disease can be obtained in twelve to fourteen days by painting the panel each tapping day, after which periodic protective painting may be given so long as the wet season persists.

During the year, ten proprietary preparations have been tested with a view to placing them on the White List of fungicides approved for control of Mouldy Rot. Of these, two only have passed the necessary tests and have been placed on the List which now

contains the following preparations to be used at the concentrations given:—

	per cent	
Killgerm	5 — 10	in water applied each tapping day
Black Cyllin	5 — 10	" " " " " "
Kilsol Red	5 — 10	" " " " " "
Agrisol White	10 — 15	" " " " " "
Prunolinum		
plantarium	10 — 15	" " " " " "
Agrisol	15 — 25	" " " " " "
Izal	3 — 5	" " " " " "
Cargillineum 'B' mixture	applied neat every fourth day.	

The higher strength is intended for use during periods of very wet weather or in damp situations.

PREPARATION OF FUNGICIDES

A further point of interest is the preparation in the laboratory of two fungicides which have given good results in field trials on several occasions. These preparations consist essentially of commercial pale cresylic acid emulsified in water with resin soap and stabilised with colloidal clay or a vegetable oil. These fluids may be used at a strength of from 5 to 10 per cent in water on the most deeply-tapped bark without risk of burning, and give adequate control of the disease.

DISEASES OF BUDDED STUMPS

A considerable number of enquiries were received in the early part of the year in connection with a die-back of the callus bark at the union of budded trees. This die-back appeared to spread upwards from the side of the pruned surface into the bark of the scion to a height of two to three feet in some cases. The cause was eventually shown to be due to excessive heat absorption by the black asphalt-treated surface of the pruning wound and surrounding bark. Experiments were carried out which demonstrated the great heat absorption by the black surfaces. A similar disease had been prevalent in Indo-China where the plant pathologists recommend lime-washing the pruned surfaces and a small area of the bark above and below the union to reflect the heat.

Other diseases, concerned chiefly with the activity of leaf and stem fungi, were also reported. Bird's Eye Spot caused by *Helminthosporium Heveae* continues to give trouble in young rubber trees.

A disease of the leading shoots associated with *Glocosporium* sp. and *Pestalozzia* sp. has also occurred in several localities. This

disease manifests itself in the death and discolouration of the stem at about 12 to 15 inches from the tip, as a result of which the leading whorl of leaves dies off and the tip of the shoot remains for a time prominently bare until new shoots grow out from below the diseased portion.

BROWN BAST

There continues to be a number of enquiries on this subject though it is becoming generally recognised that treatment by isolation, scraping or stripping is of little use, while the adoption of a less severe tapping system and continued tapping through the diseased bark will often prevent the disease from spreading further.

BLACK STRIPE AND PATCH CANKER. *Phytophthora sp.*

Sporadic occurrences of these diseases have been dealt with chiefly in the South Kedah and coastal districts of Malaya. Control of Black Stripe by the usual water-miscible fungicides is generally efficacious, while, in cases of Patch Canker, excision of the diseased tissue and protection of the resultant wounds is necessary.

PINK DISEASE. *Corticium Salmonicolor*

Outbreaks of this disease continue to occur in most inland districts during periods of heavy rainfall. Owing to the rapidity with which a strong branch can be completely ring-barked by this disease it is necessary to maintain a regular inspection of trees during the wet season. Excessive painting of immature bark by tar or asphaltum mixtures appears to exercise a choking effect on the bark and, in such cases, a 20 per cent solution of a water miscible fungicide should be used.

LEAF DISEASE. *Oidium Heveae*

This year's attack of *Oidium Heveae* has been unique in view of its suddenness and short duration. The weather during February was comparatively dry and a normal though severe wintering took place. The few trees (10—15 per cent) which refoliated and flowered during this month produced leaf and fruit undamaged by the mildew fungus. In inland areas in the States of Selangor and Perak, where heavy rain fell throughout the first five months of the year, estates were practically free from this disease and the foliage remained comparatively healthy. In the Port Dickson,

(Negri Sembilan), Malacca and Sitiawan (Perak) districts however light showers only were experienced throughout the period February to April and these, being favourable to the rapid development of the fungus, resulted in an almost epidemic spread of the disease in March when the great majority of trees were just growing their new leaf.

In Johore a few sporadic occurrences of the disease were reported. Below is given the average rainfall in inches from the various districts for the period January to May 1933:

District	Jan.	Feb.	Mar.	Apr.	May	Total
K. Lumpur (S.)	6.00	13.00	13.00	10.5	15.25	64.05
Sitiawan (Pk.)	8.30	3.64	3.86	4.08	3.47	23.35
Port Dickson (N.S.)	3.13	3.17	4.42	9.17	6.53	26.42
Tampin (do)	3.97	2.80	7.72	9.13	14.70	38.32
Malacca	6.46	0.96	10.51	8.85	3.60	30.38
Kluang (J.)	13.61	3.69	12.90	9.45	8.78	47.43

Early in February, in a letter published in the Malayan Press, a request was made to all planters to report this disease as early as possible and to forward specimens of diseased leaves for diagnosis. As a result of this a report was published in the Journal Vol. 5, No. 1. There is therefore little need to discuss this subject further in this report.

Sulphur dusting experiments have been carried out over a considerable area during the year and, though considerable improvement in foliage was obtained, it cannot yet be stated that any significant improvement in yields of rubber can be obtained by dusting.

During the year some 3000 acres of mature rubber were dusted with sulphur as a measure for control of this disease. As a result of the attention given to the mildew problem it is estimated that the area to be dusted in the 1934 season will probably exceed 20,000 acres confined almost entirely to the Malacca and Negri Sembilan districts.

F. Beeley

Insect and Animal Pests.

WHITE ANTS. (*Coptotermes curvignathus*. Holmgr)

Considerable work has been done during the year in an attempt to improve upon the methods of control of this pest which becomes more serious in young rubber each year. Experiments carried out on the R.R.I. Experiment Station and on estates indicate that

known infested areas should be thoroughly examined at intervals of not more than six weeks so that attacked trees may be treated before the termites have got too far into the wood. Undoubtedly the best method of treatment consists of exposing the tap root and lateral roots to a distance of one foot from the bole of the tree, applying an insecticidal dust to the bark, thoroughly cleaning the bole and trunk of the tree and again applying the poison dust to all damaged tissues. This treatment should be repeated after a lapse of four or five weeks.

A paper has been prepared for publication on the results of a series of experiments on the control of the termite pest of rubber trees involving various mechanical methods and using insecticides giving a range of effects viz. fumigants, contact poisons and stomach poisons and concussion death by explosive gases.

F. Bealey

COCKCHAFER GRUB (*Psilopholis grandis*).

Under this head there is nothing further to report from last year.

"NETTLE" CATERPILLAR. *Thosca sinensis*

This insect is one of the "nettle" caterpillar group. It is about 1—1½ inches in length, is a green colour and possesses a number of prominent yellow tufts of hairs on the upper surface. These tufts of hairs, when in contact with the skin, set up an intense irritation which may last for several hours. It is extremely difficult to get the labourers to work in infested fields and, in the cases noted, tapping had to be stopped until the attack subsided. While the caterpillar undoubtedly eats leaves of young rubber plants there is little direct loss as a result; the chief consideration is the indirect loss sustained as a result of cessation of tapping because the tappers will not work in infested fields.

The caterpillar usually feeds on certain types of grass, and it is only in fields of rubber where grasses have been allowed to become established that the presence of this pest has been noted. No work on the life-history has been attempted but, from information supplied, the main attack in the field subsides in about one month. Later, a less intensive attack occurred which again subsided in about one month. At a later date, the caterpillars again appeared, but in much smaller numbers. It would appear that the caterpillar period lasts for about one month, which would be expected if the life-history of closely-related insects is considered.

It is obvious that serious losses may be brought about if heavily infested fields have to be closed down during the month of infection. The clearance of all grass from the infested fields will easily control this caterpillar.

A. Sharples

SPIDER PEST

The next disease of importance which came to the fore during the Oidium investigations was the occurrence of an Attid Spider on the young leaves of rubber trees which, though it does not appear to be a parasite in itself, creates conditions attractive to other insect parasites. These spiders which are extremely small (about 1/16—1/8 inch long) weave a scarcely visible web around the very young rubber leaves. Leaves so bound together in triplets form an ideal damp chamber for the development of leaf-spotting fungi of the *Helminthosporium* and *Glocosporium* types. These fungi cause discolouration and death of the leaf tips in which stage the disease may closely resemble mildew caused by *Oidium Heveae*. Later the leaves are torn apart by the wind thus resulting in the ragged appearance of the leaf. Other insects associated with this disease are the leaf-eating weevil *Phytoscapus leporinus* Faust and the common mite *Tarsonemus translucens*. This spider pest has been active particularly in young immature rubber, 1—6 years' old, in Selangor, Perak, Kedah and Johore and occurred chiefly in the months of April and May.

F. Beeley

RAT DAMAGE

Several cases of rat damage have been reported during the year. In all cases, the infested areas carried a strong thick growth of *Centrosema pubescens* and the trees are ring-weeded. The runs and rat holes are frequently found at the edges of the rings formed by cutting back the cover crop.

On the stunted trees in a young budded area on poor soil the scarred places caused by the animals extend from the union upwards to the commencement of the green bark of the scion. The scars are mostly small, vertical irregular oblongs and at the first glance one becomes suspicious of rodent damage. On many trees the scars are closely placed all round the tree and throughout the length of the harder, mature, brown bark portion, usually, though not invariably, leaving the more tender, recent growth at the top untouched. Sometimes the cambium and even a small part of the wood beneath is removed. Scattered affections may be seen here and there between and around each area.

In another area with well-grown, normal budded trees the animals appeared to have a fondness for the corky bark of the stock below the union and for that of the scion immediately above the union. In many cases, holes have been scooped out around the stock and the trees may be completely ring-barked in consequence, but none have died up-to-date. Here and there the cambium is damaged but as a rule the wood is untouched and, on these larger trees, it is rare that scarring occurs above a few inches from the ground. The severity of the wounding renders it doubtful whether the trees will ever recover perfect bark conditions but, in the writer's opinion, they should do so if further depredations by the rodents can be stopped.

The control suggested is the use of poison baits, prepared in the way suggested by the Department of Agriculture Rat Destruction Officer, Krian.

A suitable bait is made up of the following ingredients:—

	Vols.			Ozs.
Rice polishings	...	4	approx.	46
Tapioca flour	...	2	"	45
Tallow	...	1	"	4
Palm Oil	...	1½	"	47
Water	...	1	"	24
Salt	...	1	"	3
Sodium arsenite	...			18

The above ingredients are mixed thoroughly and then run through a mincing machine with a specially large delivery plate which turns out balls about the size of an ordinary marble, calculated to give approximately 0.7 grain of sodium arsenite to each ball. After being machined, the balls are dried and stored if not required for immediate use; they keep indefinitely.

Barium carbonate or strychnine may be used as alternative poisons for sodium arsenite. When a change of bait becomes necessary a line of steel traps should be run for a few nights, followed by poisoned grasshoppers, before a return is made to poison baits.

A. Sharples

General diseases of young rubber

Slugs and Mites have been troublesome on young budded trees in certain districts. As a result of their activity the young plants appear almost denuded of leaves while the leading shoot often assumes an abnormal, fasciated condition.

These pests also attack seedling rubber as described above but the damage is not so noticeable owing to the practice of planting several seeds at each stake.

Other diseases reported were usually found to be abnormalities of physiological origin such as lack of water, lack of nutrients in soil, and overheating of the stem by the sun's rays reflected from a white sandy soil surface.

F. Beeley

Lectures and Demonstrations.

1. Demonstration of Sulphur dusting on Sepang Valley Estate March 1933 by F. Beeley and A. Moore.
2. Demonstration of Sulphur dusting on Bhutan Estate, March 1933 by F. Beeley and A. Moore.
3. Demonstration of Sulphur dusting on Gadek Estate, April 1933 by F. Beeley and the Manager.
4. Lecture on "Sulphur Dusting in the Control of *Oidium Heveae*" by A. Moore at the Nilai Branch, Incorporated Society of Planters.
5. Lecture on "*Oidium Heveae* and its Control" by F. Beeley at the Incorporated Society of Planters' Annual Conference, Taiping.
6. Lecture and Exhibit on "Root Diseases of the Rubber Tree" by R. P. N. Napper, Malacca Planters' Association.
7. General exhibits of the more important diseases of Hevea were staged at the Malayan Agri-Horticultural Exhibition, Kuala Lumpur.

Publications.

Two articles by members of the Division have been sent home for publication in English scientific publications and both were accepted.

These articles were:—

1. Lightning Storms and their Significance in relation to Diseases of (1) *Cocos nucifera* and (2) *Hevea brasiliensis* by A. Sharples.

Annals of Applied Biology Vol. XX, No. 1, February 1933

2. Callus Formation in *Hibiscus Rosa-sinensis* L. and *Hevea brasiliensis*. Mull Arg. by A. Sharples and H. Gunnery.

Annals of Botany Vol. XLVII, No. CLXXXVII October 1933.

The following articles have been published in the Journal:

1. *Oidium Heveae*—Report on the 1933 Outbreak of Hevea Leaf Mildew by F. Beeley, Journal Vol. 5, No. 1

2. Lightning Damage in Rubber Plantations by A. Sharples, Journal Vol. 5, No. 1.

3. Report on Diseases of the Rubber Tree in Kedah, by R. P. N. Napper, Journal Vol. 5, No. 1.

A. SHARPLES

Head of Pathological Division

APPENDIX

In addition to the enquiries dealt with and the investigations carried out in connection with the correspondence included as an Appendix to the Director's report, the following specimens have been received for examination:

Budded Stumps	...	22
Seedlings and Shoots	...	7
Leaves	...	35
Branches	...	4
Bark	...	13
Roots	...	15
Insects	...	9
Miscellaneous	...	13
Total		118

ANNUAL REPORT

CHEMICAL DIVISION

STAFF

Throughout the year the staff has been seriously below strength and has consisted for all practical purposes of two officers. Drs. Wiltshire and Rhodes were available for duty throughout the year and Mr. Hastings assumed duty as a member of the Division in mid-November. The Technological and Advisory Division became operative during the last quarter of the year and has given some assistance during that period.

Latex Constituents

QUEBRACHITOL

Further requests have reached us from various sources for supplies of this latex constituent, but it now seems unlikely that there is a future for it as a by-product from latex. If it could be produced at a price comparable with that of glycerine, it would almost certainly find a use as a raw material for the manufacture of explosives, but our investigations lead us to the view that the production costs of quebrachitol must of necessity be considerably higher than those of glycerine.

The recent publication by Drs. McCance and Lawrence in the *Biochemical Journal*, describing tests made with quebrachitol from this Institute on diabetic subjects, may bring in its train further requests for supplies of the material for academic study, since the substance is probably unobtainable in the world except from the Institute. One such request has already been received from the Pasteur Institute, Paris, and a supply has been despatched. It is felt that, although there may not be a commercial future for this material, it would be well for the Institute to remain in a position to supply relatively small quantities to scientific institutions which may desire it, and which might not otherwise be able to obtain it.

CRUDE SERUM EVAPORATES

In connection with the researches at present being carried out under the auspices of the Rubber Growers' Association crude serum evaporates were prepared for the furtherance of the London investigations.

At the request of the scientific staff of the London Advisory Committee, a series of evaporates was prepared for an investigation of their effects on dry rubber. The samples included crude evaporates, together with fractions from which certain constituents, chiefly quebrachitol, had been variously removed by fractional crystallisation.

HEVEA LIPIN

Samples of this latex constituent were prepared for Imperial Chemical Industries Ltd., but it is again unlikely that the material can prove to be of more than academic interest.

THE SEPARATION OF NON-CAOUTCHOUC CONSTITUENTS OF LATEX

Circumstances have not permitted the furtherance of this branch of the work to the hoped-for extent. By butyl alcohol extraction of concentrated dialysates, with subsequent fractional crystallisation of the extracts, a large number of interesting fractions have been obtained which it has not, so far, been possible to characterise. Some fractions are extremely deliquescent and it is hoped in the coming year to determine the nature of the deliquescent constituents, with the presence of which certain properties of raw rubber are intimately connected.

By repeated extraction of dry dialysate solids with 90 per cent ethyl alcohol, followed by methyl alcohol extraction of the ethyl alcohol solubles and repeated crystallisation of the methyl alcohol extracted material, an apparently uncrystallizable syrup was obtained, which was found to consist mainly of a complex sugar. In its original condition it has no reducing properties but, after hydrolysis, reduction is vigorous and osazones are readily produced. It is extremely probable that, in fresh latex, simple reducing sugars are not present and that the true sugars exist in this more complex form.

Latex Preservation and Concentration.

GENERAL

The demand for preserved latex has been well maintained and shipments of the commodity, both in the normal and in the concentrated state, have been much higher than in the preceding year. One large organisation has re-opened its installation for the bulk shipment of normal latex and another large group has installed and is working at another port, an installation for the bulk shipment of centrifugal concentrate. Indications are not lacking how-

ever that the market for latex will only continue to increase, provided that producers can satisfy the more exacting demands of the buyer. The development of the latex industry depends to a great extent upon a supply of uniform latex of good colour and stability and it is becoming increasingly evident that estates which are not able to satisfy these requirements may find future contracts difficult to obtain.

COLOUR OF PRESERVED LATEX

During the year, enquiry has been made into the causes of discolouration of preserved latex and it is hoped during the coming year to publish a preliminary statement on the subject. It is now felt that the major causes have been traced, but the remedies are by no means simple, since they are partly connected with the type of container at present in use. There is no doubt that there is an urgent need for a type of container other than the steel drum and the kerosene tin. It is tolerably certain that many estates whose latex, when shipped in these containers, reaches destination in a discoloured condition, and is made the subject of complaints, would have a much safer market if a really satisfactory and at the same time cheap container could be devised. The container problem is not easy of solution since many suitable types are automatically placed out of court by their cost. Experiments have been made with wooden barrels but there is at present some doubt as to whether these will meet with a general acceptance among buyers. There is considerable scope for experiment on the internal treatment of metal drums and work on these lines is proceeding side by side with the search for new types of containers. In the course of work on the discolouration of preserved latex, two chemical substances have been found which, when applied to an already badly discoloured latex, will quickly discharge the blue-grey colour and restore a good appearance; after such treatment, the undesirable colour tends however to re-appear on continued storage. Both chemicals, when added to freshly-preserved white latex, retard considerably but do not completely prevent the appearance of the undesirable blue-grey colour. Experimental batches of chemically treated latex have been shipped to a large American buyer for opinion. No recommendations can be made to estates on the chemical treatment of latex against discolouration, unless it can be established, by very full and careful enquiry, that such pre-treatment would be desirable and would be welcomed. It is very likely that buyers would be prejudiced against a pre-treated latex and that they them-

selves would prefer to apply the chemical treatment when the latex reaches destination.

VISCOSITY AND SPECIFIC GRAVITY OF PRESERVED LATEX

(a) *Viscosity*

American and other buyers have observed that considerable variations in viscosity occur within any one shipment of latex from the same source and between successive shipments. Such variations are undesirable. By the courtesy of Dunlop Plantations Ltd., and Kepong Estates Ltd., we were enabled to examine the viscosity of a large number of samples of preserved latex and centrifugal concentrate and were provided with information as to weather conditions on each tapping day. It was thought that the viscosity of normal preserved latex might be closely connected with weather conditions but, in a large number of tests, the fact has emerged that wide viscosity variations may occur even when weather conditions, tapping conditions and dry rubber content are apparently unchanged.

The work is being continued but the indications at present are that close control of viscosity under estate conditions would be almost impossible and that the best method of obtaining reasonable constancy lies in the large-scale bulking of latex before shipment.

The natural change in viscosity of preserved latex with time of storage, has also been investigated. With ordinary preserved latex, the viscosity falls fairly rapidly in the first few days of storage, but thereafter more slowly. There is however wide variation in the degree of fall from sample to sample; in a storage period of three weeks, one latex sample may show a viscosity fall three times greater than that shown by an apparently identical sample drawn from the same area but on a different day. Large-scale bulking should again tend to smooth out storage variations.

With centrifugal concentrates having a high dry rubber content of the order of 58–60 per cent, the viscosity is naturally many times greater than that of a normal preserved latex and slight variations in dry rubber content produce comparatively large viscosity differences. Cases have been observed in which the viscosity of concentrates increased rather than decreased in storage. The advantages of large-scale bulking are again apparent.

(b) *Specific Gravity*

A large number of gravity determinations have been made on preserved latices from many sources and covering a wide range of dry rubber contents. Variations in specific gravity between

samples from the same source and of similar dry rubber content are again appreciable; variations in the amount of the non-caoutchouc constituents of latex account in part for the variations observed in specific gravity. These observations merely serve further to confirm the oft-emphasised fact that gravity determinations, whether made by specific gravity bottle or hydrometer, cannot be used except as a very rough gauge of the dry rubber content. Certain authors have in the past used specific gravity determination as a means of arriving at a value for specific gravity of the latex globule in fresh latex; the work now in progress on preserved latex should eventually provide a confirmation or otherwise of the values already found.

ALTERNATIVE PRESERVATIVES FOR LATEX

(a) Consignments of latex preserved with caustic potash and with formalin have been shipped from various Malayan estates to Continental and other buyers. A demand for these types of preserved latex does therefore exist, but it is small. The amount of commercial formalin used for preservation, has been 64 fluid ounces per 40 gallons of latex. Formalin-preserved latex, by contrast with ammoniated latex, becomes extremely viscous after storage for a few days and, on this account, commends itself only for certain specialised uses.

Tests have been made at the Institute with a number of materials proprietary and otherwise.

(b) *Triethanolamine (trihydroxyethylamine) and its fatty Acid Derivatives*

These bodies have been proposed in the latex industry as dispersion agents and stabilisers for preserved latex and tests were made to determine their suitability as preservatives for fresh latex. Triethanolamine is a liquid and is a weak base. When applied to fresh latex in amounts up to 3.0 per cent by volume it proved unsatisfactory for long-period preservation; its use in such an amount would be quite prohibitive on account of its cost, even were it satisfactory. The solid and liquid fatty acid derivatives, namely the stearate, the oleate and the linoleate, were also unsatisfactory even when used as dispersions in amounts up to 4 per cent. by weight.

(c) *Hypochlorite solutions*

The patent literature reveals references to the use of these bodies as preservatives of de-ammoniated preserved latex. Trials were made on fresh latex but, although preservation was possible

over a period of a few days, long-period preservation was difficult and it is not considered that this class of substances has a real future in the preservation of fresh latex.

(d) "*Abracide*"

This new proprietary general disinfectant was applied to latex in the form of a dispersion in soft soap. Over a wide range of concentrations it proved unsatisfactory as a preservative.

(e) *Proprietary "Latex Disinfectants"*

Chief among these bodies are two productions which have been developed by a well known American chemical organisation and which have, it is understood, been used with success in America on de-ammoniated preserved latex; they are styled "FD.2" and "FD.4" respectively. They are readily soluble in water and are alkaline. When applied to fresh latex in amounts up to 1 per cent, which is much in excess of the prescribed dose, they were both found to be unsatisfactory, in that there was a tendency towards clotting and discolouration during a storage period of a few days.

The search for alternative preservatives has not therefore resulted in the discovery of any new substance worthy of extended trial.

LATEX CONCENTRATION

(a) *Concentration by Creaming*

Experiments on this method of concentration have been continued throughout the year. It is unfortunate that the legal position with regard to the master patents for this process remains obscure. Protection is being sought for a modification of the gum tragacanth process but the comprehensive terms of the master patents would preclude the safe adoption of the modified process by Malayan producers.

The unsatisfactory creaming powers of certain samples of gum tragacanth powder have been traced to adulteration with a different type of gum which is a non-creamer.

Creams have been prepared by the use of gum tragacanth in latex treated with mixed preservatives and at least one of these types was markedly different in certain respects from the normal types. Samples were despatched to England for users' opinions.

Experiments have been made with the object of overcoming the undesirable tendency of gum tragacanth creamed latex, towards "after-creaming" on storage. While no great measure of success attended experiments with added chemicals, it was found that certain of the bodies, with which the latex was treated, had the effect of increasing the rate of creaming and of improving the dry rubber content of the final cream.

It has been found however that the degree of "after-creaming" can be greatly reduced by the use of a creaming vessel having side taps so disposed that almost all the cream can be run off without disturbing the serum below. By this means the slight re-mixing of serum and cream which occurs when the serum and cream are run off from a tap situated at the bottom of the vessel, is avoided and "after-creaming" is less pronounced.

The variability of gum tragacanth samples detracts from the value of this creaming agent and attempts have been made to discover alternative creamers. Some gums and mucilages from local and Indian plants have been tested without success but in the course of the year two creaming agents have been found which are used for other industrial purposes, and in which constancy of composition and performance should be more certain than is the case with gum tragacanth. One of the substances, is a synthetic product which is unfortunately expensive and which is perhaps not quite so efficient a creamer as the best varieties of tragacanth; the other is a seed gum which is considerably cheaper than gum tragacanth and which was kindly supplied to us by Imperial Chemical Industries (Malaya), Ltd. The optimum conditions for creaming with this latter product have been explored and there is little doubt but that it is a more suitable creaming agent than gum tragacanth. Samples of the cream prepared by its use travelled well and reached England in good condition. The creaming agent can now be purchased in quantity in Malaya.

(b) *Centrifugal Concentration of Latex*

It has been possible during the year, to make small-scale concentration trials at the Institute with a centrifugal machine kindly loaned to us by Messrs. Watson, Laidlaw & Co. Ltd., Glasgow. With this machine it was found possible to prepare concentrates having a dry rubber content of 60 per cent. but the corresponding skim fractions were rather richer in rubber than would be considered desirable. The dry rubber content of the skim fractions was of the order of 14 per cent. Useful information was obtained upon the effect of variation in input rates, plate

separations and upon the effect of period of storage prior to centrifuging. The work will be continued in the coming year with another type of machine.

In concentration by centrifugal means, the treatment of the skim latex presents a problem. The amount of rubber present in the skim is not large but it is large enough to make its recovery worthy of serious consideration. It is unfortunately the fact that acid coagulation of the skim is difficult and expensive, and it does not yield first-grade sheet rubber; crepe of reasonable quality can however be prepared from it. Experiments were made at the Institute on enzymic coagulation of stored skim. It was found that this method of coagulation was also expensive but that it yielded an unusually soft sheet rubber. Protection for this process may be sought during the coming year.

It is reported that, on a certain property not situated in Malaya, centrifugal skim from an experimental machine, has been used in the field with success as an anti-coagulant for the main bulk of latex intended for sheet manufacture.

(c) *Concentration of latex by evaporation*

While in England on leave the Director and Mr. Bishop were able to interest Messrs. Kestner Evaporator & Engineering Co. Ltd., in the matter of concentration of latex by evaporation. Preliminary trials were conducted in London with preserved latex in a small Kestner spray drier. The trials gave encouraging results and the inference is drawn that such a plant, of which the cost would be approximately £950 and the expected throughput 46 gallons of latex per hour, presents possibilities as a latex concentrator, alternative to existing types.

Clone Rubber and Clone Latex

Systematic work, on the vulcanisation properties of the rubber from the Pilmoor Estate clones, has continued throughout the year; side by side with this work the chemical composition of the latex from the various clones has also been studied. Quite apart from the possibility of correlating variations in the vulcanisation properties of the rubber with variations in the chemical composition of the latex, the work on clone latex has had for a major object an endeavour to obtain a better insight into the fundamental problem of the physiology of latex production and has been planned to give information upon the reaction of the tree, as indicated by latex differences, to different tapping systems, height of tapping and seasonal variations.

CLONE RUBBER

The practice of determining for each clone the tensile modulus, from samples drawn from a whole month's crop has been continued and, by this time, such figures are available for practically two complete years. A discussion of the results is not now presented since it would merely anticipate a publication which will appear in the new year, giving a complete statement of the work to date. It is sufficient to state here, that there are strong indications that the seasonal variations in tensile modulus are greater than the innate differences between rubber from the clones examined and that the clones show marked parallelism in their reactions to seasonal changes.

During the last four months of the year the Bierer-Davis ageing bomb has been in continual use and ageing results have been obtained for the clone rubber produced in the months of July, September and October. In order to obtain a standard of reference, similar examinations are in progress on samples of smoked sheet from twelve estates in various parts of Malaya.

CLONE LATEX

A publication will shortly be issued giving a complete account of the very large number of chemical examinations which have been carried out over a period of one year and, as in the case of the work on clone rubber, it is not intended to anticipate the publication by a discussion of the results obtained. It can be indicated that the work has embraced:—

- (a) the effect of height of tapping on the composition of the latex,
- (b) the effect of two cuts at different heights on different trees and on the same tree,
- (c) the effect of different tapping systems.

For the purpose of comparison, observations have also been made on latex from seedling rubber under various tapping systems.

In addition to this study of the variation in the composition of latex from different sources, further experiments are in hand which are designed to throw light on the genesis of latex in the tree.

The work on clone rubber and latex has been in charge of Dr. Wiltshire throughout the year.

Alternative Coagulants

SULPHURIC ACID

The number of enquiries concerning the use of sulphuric acid as a coagulant has declined during the year; it is probable that

the decline is directly connected with the better price obtainable for rubber in recent months. Sulphuric acid, although cheaper than the more common coagulants, is less simple to use, and its use necessitates closer supervision. During the year a series of samples of sheet rubber prepared at the Institute by coagulation with sulphuric acid, was despatched to London at the request of the London Advisory Committee and the India Rubber Manufacturers' Association for complete tests in simple rubber-sulphur and in technical mixes. The full report when available should decide finally to what extent if any, the fear that it is a dangerous coagulant, is well grounded.

"FIRST PARA MAKER"

During the year, literature on the use of this material was widely circulated by its German manufacturers and samples were received at the Institute for test. The claims made for it are threefold and are briefly that it produces a rubber similar to Fine Hard Para, that the process of smoking can be eliminated, and that it simplifies the process of sheet manufacture. It was recommended that an amount of the coagulant, which is a liquid, equal to 3-4 per cent of the volume of the undiluted latex, be mixed into the latex and that, when coagulation and machining are complete, the sheets can then be dried in the air without smoking. In our hands it was found impossible to mix the coagulant uniformly with fresh latex. Immediate local clotting occurred, even when the coagulant was introduced from a fine spray. The manufacturers supplied later, modified materials for emulsification with water before addition to the latex. It was found in practice that these modified preparations did not give stable emulsions with water, and that, even with perfectly fresh emulsions handled under laboratory conditions, the coagulation was very local, unduly rapid and very uneven. The conclusion was reached that these preparations have little or no future in estate practice; while it is a fact that a few sheets were prepared and that these did dry in air, to the colour and with the smell of smoked sheet, the coagulation process itself would be almost unworkable on an estate scale.

Similar conclusions were reached at the A.V.R.O.S. Proefstation and these were issued in Circular No. 103. In this circular it was rightly pointed out that, since the process is one of coagulation in which serum constituents must be lost, the rubber must obviously be dissimilar from Fine Hard Para which is prepared by evaporation and without loss of serum constituents. It was further pointed out that, while smoke itself might be unnecessary, some form of chamber, either naturally or artificially heated, would still be

necessary. The cost of the material was also considered and it was calculated that, assuming satisfaction in other respects, the cost for coagulant alone would amount to 10 guilder cents per kilogram or 4.5 guilder cents per pound of dry rubber; such a cost would be prohibitive unless a very high premium could be obtained.

Mould Preventives for Sheet and Crepe Rubber

"ABRACIDE"

This recently-developed proprietary disinfectant was tested on sheet and crepe rubber against para-nitrophenol as a standard; in our hands its effectiveness was less than that of para-nitrophenol and it is not considered to have a future as a mould preventive in the preparation of raw rubber.

"HYGENOL"

This material is an emulsion, of which the active principle and major constituent is Pine Oil. When tested against para-nitrophenol on sheet and crepe it was found to be inferior to the standard material as a mould preventive.

Modified Rubbers

It has been possible during the year to prepare a number of samples of rubber for test by the scientific staffs of the London Advisory Committee and the Rubber Growers' Association. In this connection the work has been directed along four main channels, namely the production of (i) soft rubbers, (ii) rubbers from which vulcanised articles would be odourless, (iii) rubbers having the property of low water absorption and (iv) "dead" rubbers. A discussion of the work carried out under each head follows:—

SOFT RUBBER

Reference has already been made to the enzymic coagulation of stored centrifugal skim latex, and to the probability of seeking protection for the process in the coming year. Samples made at the Institute and passed to the London Advisory Committee include rubber from skim latex, stored for varying period of time before coagulation, rubber from latex and from fresh latex ammoniated immediately before coagulation.

A range of samples was produced by incorporating into latex a water emulsion of the proprietary rubber softener "Plastogen".

A note will shortly be published, indicating that these experiments did not achieve the desired result.

Crepe was obtained from latex heated in an autoclave to bring about coagulation. Similar samples prepared by a private investigator were also passed to London. The results of the tests indicate that rubber of this type is not likely to be of special utility.

Sheet rubber from latex to which alkaline hypochlorites were added immediately before coagulation, and from latex preserved for a few days with such solutions, was despatched for test. Time has not yet permitted the completion of the work by the scientific staff in London.

Rubber has also been prepared from fresh latex to which sodium nitrite had been added. It is expected that this type of rubber will prove to be similar to that previously prepared by the scientific staff of the London Advisory Committee from preserved latex.

Mr. H. D. Jensen, Manager, F.M.S. Rubber Co., Kajang, passed to us for transmission to London, special samples of crepe prepared by him with the object of achieving softness. Results are not yet available.

RUBBER FOR THE PRODUCTION OF ODOURLESS MANUFACTURED ARTICLES

In response to a request from the Rubber Growers' Association, under whose auspices research work on this subject was proceeding, a number of crepe rubber preparations were made from a wide range of latex dilutions and from latex preserved for some days with ammonia and with hypochlorites before coagulation. The London investigations on these preparations are not yet completed.

RUBBER HAVING THE PROPERTY OF LOW WATER ABSORPTION

In the manufacture of cables, ebonite and electrical insulation articles generally, there is a demand for a rubber of which the tendency to absorb water is low. Systematic work was commenced upon this matter late in the year by Mr. Hastings. The work has, so far, been confined to the examination of sheet rubbers from latex variously diluted and from coagula and wet sheet variously soaked and heated. In addition to the tests on samples prepared at the Institute, crepe samples have been kindly provided for test by two selected estates. The work is not yet sufficiently advanced for conclusions to be drawn.

"DEAD" RUBBER

With the object of producing a rubber having the property of "deadness", a number of samples containing various proportions

of rubber and bitumen were prepared and despatched to London. Tests have indicated that, even with high proportions of bitumen, true deadness is not obtained.

Sheet Preparation

Arrangements with Kepong Estates Ltd., for the use of an estate factory, are now practically completed. It should therefore be possible during the coming year to extend the scope of the work on rubber preparation.

SHEETING BATTERIES

No marked advances in sheeting procedure have been made during the year under review. Many estates have installed new line-ahead batteries of one or other of the various proprietary types now available but the majority of the new batteries are operating on a non-continuous coagulum. The new compact types of battery, to which reference was made in the last report, have not yet become available to the public, but it should soon become possible to test the efficiency of one of these types.

SMOKE DRYING

The drying chambers developed, protected and marketed by Socfin Co., Ltd., have been erected on a number of estates to replace existing types. These drying chambers are equally well adapted to the preparation of smoked or air-dried sheet and drying is complete in forty-eight hours, with sheet of which the thickness is slightly less than $\frac{1}{8}$ inch.

Service Trials of Rubber Flooring

In response to a request from the Rubber Growers' Association, the Chemical Division has collaborated with the Federated Malay States Railways in a service trial of a number of different makes of rubber flooring. The various samples forwarded by the R.G.A. after comprehensive laboratory tests in England were laid by officials of the F.M.S.R. on the verandah ends of the rake of coaches which make up the Kuala Lumpur—Penang day mail train.

Institute officers have given such assistance as has been necessary and have made examinations of the samples from time to time. Certain of the samples are, after three months' service, beginning to show the effects of the rather drastic conditions to which they are being subjected, and it should soon be possible

to decide which grades and makes of flooring are best suited to tropical conditions.

Baling Experiments

Baled rubber was prepared by courtesy of Dunlop Plantations Ltd., and shipped in coverings of three types:—(a) Sized hessian (b) Sized gunny and (c) Mengkuang matting. There were three variations of each of the three types of bale:—(i) each sheet dusted with magnesium oxide or with magnesium-oxide-zinc stearate mixture before baling, (ii) outer wrapper sheets of each bale dusted with the dusting powders above and (iii) undusted controls. It was reported from London that, in all cases, massing of the rubber had taken place, though this was least pronounced in the bales in which each sheet was dusted. Of the three types of covering, the mengkuang matting appeared to be the most satisfactory but was not the ideal wrapper.

Further baling experiments will be undertaken in the coming year.

Rubber Roadways

Work on this subject was continued until the month of May during which a trial stretch of roadway was laid on the Kuala Lumpur—Port Swettenham Road. The work was placed in abeyance on the departure of Mr. Hastings on home leave.

A report on this subject is presented separately.

Advisory Work and routine Chemical Examinations

The majority of the samples examined during the year have again consisted of preserved latex and this subject has brought more enquiries than any other single item of advisory work.

Enquiries on the manufacture of smoked sheet and crepe, and on the machinery and buildings appertaining thereto, have as usual been numerous.

It was mentioned, in the last report, that recommendations had been made to a manufacturer of a particular type of hydrometer, with the object of correcting an error which appeared to be roughly constant. It can now be recorded that the makers have acted upon the recommendations and with success; recent shipments of this type of instrument have been greatly improved and the constant error has been virtually eliminated.

Lectures and Demonstrations

A talk was given by Dr. Rhodes to the Bahau-Tampin branch of the Incorporated Society of Planters at the Bahau Dunlop Club on "Industrial Uses of Latex".

Dr. Wiltshire addressed the Annual Conference of this Society at Taiping, on the subject of "New Uses and Consumption of Rubber".

Publications

- | | |
|------------------------|---|
| (i) Papers | Malayan Patents relating to rubber by J. L. Wiltshire. |
| (ii) Information Cards | These have been revised, and will be issued early in the new year in the form of cards suitable for desk or wall use. |

Malayan Agri-Horticultural Show

The exhibit at this Exhibition held in August followed closely the lines of the previous year's display. A special feature which attracted much attention, was the collection of manufactured articles made from latex. This included samples of the new Dunlopillo upholstery, and latex thread with articles made from the latter.

The number of enquiries on rubber subjects, made during the Show, was far greater than in the previous year and this in itself was very encouraging to the officers of the Division.

EDGAR RHODES

Head of Chemical Division

Kuala Lumpur,

29th January, 1934

ANNUAL REPORT

RUBBER ROADWAY INVESTIGATIONS

The work on rubber roadways was continued until May 1933 when the writer proceeded on home leave. Since this time active research has been in abeyance.

In the Annual Report for 1932 it was reported that the large scale experiments made at the Institute towards the end of 1932 appeared sufficiently promising to proceed with the laying of a trial under service conditions. The opinion was also stated that there was little prospect of the production of a satisfactory material from field latex and that a mix consisting mainly of a concentrated latex—prepared by creaming—together with aluminous cement and sodium silicofluoride as a delayed coagulating agent promised to be more suitable. During 1932 it was the practice to mix the fillers with the stabilised latex by means of an electric stirrer sufficiently powerful to give a deep vortex while mixing was in progress. A portable mixer of a similar type was necessary before an actual service trial could be laid. The assistance of the Public Works Department engineers was sought and a petrol engine-driven mixer was constructed. Trial mixings indicated various necessary modifications and these were made before work on the trial stretch was commenced.

In May 1933 it was possible to undertake the laying of a trial stretch of roadway. A site was selected at $4\frac{1}{2}$ miles from Kuala Lumpur on the Kuala Lumpur—Port Swettenham road. Here traffic is fast and fairly heavy. The road at this point is approximately 22 feet wide and the area laid was one chain in length over the full width of the road. The bitumen surface of the road was scarified and a cement grout applied; this procedure was adopted because previous experiments had indicated that the preparation would not anchor satisfactorily when laid on asphalt. No by-pass is available and the road was therefore of necessity treated in two halves. Each half was opened to traffic six days after the laying of the last bay.

This trial stretch has now been under traffic for six months and it is evident that the material is not entirely satisfactory in respect of ageing properties. Actual wear does not appear to be severe but some softening of the material soon became apparent, and it was necessary to apply a thin surface paint of bitumen. It is not possible to state whether or not the deterioration is due to over-vulcanisation or to the poor ageing properties of the mix. It may

be noted that some cowstalls laid with similar material in the cattle shed at the Central Experiment Station, Serdang, have not so far shown this defect. The standings are under cover and are not exposed to the direct heat of the sun. It is also a fact that a small section of the road laid at the Institute over a year ago, and shaded by neighbouring trees, has not shown by any means so marked a deterioration.

Aluminous cement such as Ciment Fondu is an expensive form of filler and quick lime has been tried as a dehydrating filler. Experiments were made with creamed latex and quick lime ground to a very fine powder. When used without additional quantities of cement it was not possible to compound the latex with an amount sufficient for complete dehydration and moreover, the rapid absorption of water, with consequent generation of heat, made the materials useless. When used as a part substitute for the cement, no improvement was made. Preparation and laying of the mixes was difficult and only a small proportion of the normal requirement of cement could be substituted by lime.

During the year, two other trial areas of rubber roadway surfacing materials were made by the Public Works Department in collaboration with the Rubber Roadways Committee of the Institute. Both were laid in Kuala Lumpur at the request of the inventors. The site is in Victory Avenue between the Public Works Department offices and the Chartered Bank. The Section on the side nearest the P.W.D. offices is laid with the 'Silent Roadway' material of Messrs. Kendall and Graham; that nearest the Chartered Bank is the material known as the P.D.C. jointless rubber paving.

Time alone will decide as to the degree of success of these trials, but it is certain that no latex mix at any rate has yet been evolved, of which it can with truth be said that it possesses no defects or disadvantages.

J. D. HASTINGS

Chemist

Kuala Lumpur

29th January, 1934

ANNUAL REPORT

EXPERIMENT STATION

ACREAGE STATEMENT

Planted	...	811 $\frac{3}{4}$ acres
Cleared not to be planted	...	7 "
To be planted	...	5 $\frac{1}{2}$ "
Elephant belt	...	96 "
Building site and roads	...	65 "
Total opened area	...	985 $\frac{1}{4}$ "
Jungle reserve	...	1110 $\frac{3}{4}$ "
Total area under application	...	2096 acres

An internal survey of several blocks was completed and the adjusted area is now as stated above.

DISTRIBUTION OF LAND

Botanical Division	...	541 $\frac{1}{4}$ acres
Pathological Division	...	28 "
Soils Division	...	255 "
Building site & elephant belt	...	161 "
Total	...	985 $\frac{1}{4}$ acres

The Pathological Division carries out all pest and disease work over the whole area.

CLEARING

No extension of planting on the reserve area was carried out during 1933.

The area mentioned in the report for 1932, which was considered suitable for our requirements, could not be released by the Forest Department, so that the matter of a transfer of land has been in abeyance. It is hoped to obtain an area of approximately 300 acres, at the south-western end of the present opened area, in exchange for our present reserve. This area contains much undulating land and the soil is good. Negotiations for the transfer are in progress.

LINING, HOLING AND PLANTING

Certain small areas, including an old nursery site, were planted during the year.

Block 20A.—An area (3 acres) near the north boundary of the original Block 20, was thoroughly cultivated and the old material, unselected seedling trees planted 30 ft x 30 ft, was removed. Planting at 15 ft x 15 ft was completed in November with seedling stumps grown from seed of proved clones in an isolated seed garden.

Block 9A.—This area had been reserved since October 1928 for the study of wood-rotting fungi by the Pathology Division. Investigations having been completed, the remaining debris was burnt, old jungle stumps were removed and the area prepared for planting 22 ft x 11 ft. Planting was completed in November with seedling stumps grown from seed of Clone A.V.R.O.S. 157.

Block 25.—The old nursery site, approximately 6 acres, was cleared and planted 20 ft x 20 ft with good seedling stumps, derived from clonal seed. This area will be used by the Botanical Division to extend the work on testing of new clones.

NURSERIES

Block 4. Botanical Division Main Nursery

Old nursery beds, containing buddings of the older clones already established in permanent plots, were thoroughly cleaned, cultivated to a depth of 3 feet and the beds rebuilt.

Nursery beds have been replanted with unselected seedling material for further budding work and clonal seedling from the older budded blocks on the Station and from monoclonal plantings on estates.

Dusting with sulphur against "mites" and spraying with kerosene emulsion for "black scale" has been carried out in the young nursery areas when necessary.

Block 12.—Selective thinning of this nursery, which is being carried on as a small Forestry Experiment, is being continued.

MANURIAL TREATMENTS

Block 6.—The annual application of cattle manure and artificial fertilizer was completed and girth measurements were taken.

Block 17A.—Quarterly applications of cresite and magnesium sulphate were stopped, after an application on 17th May, 1933.

Block 4.—Young seedlings in the Botanical Division nursery received a dressing of “Sterameal” or “Enpekay” at the rate of 2 ounces per square yard.

Block 18.—Growth in this block (75 acres) has been very backward from the beginning and a general manuring was recommended by the Head of the Soils Division. Manuring at the rate of $\frac{1}{2}$ lb. “Sterameal” or “Enpekay” per plant was accordingly carried out.

CATCH CROPS EXPERIMENT

Block 23.—In this area, comprising 65 acres, which is planted with seedling rubber and is interplanted with coffee, tapioca and pineapples respectively and in control areas under cover crops, interesting observations have been made during the year.

The tapioca was cropped in December for the third time and 438 piculs were harvested, as compared with 490 piculs in 1932 and 396 piculs in 1931.

Heavy infection of the tapioca roots by *Fomes lignosus* was found throughout the plots.

Half of each tapioca plot has been replanted, and the remaining half has been left unplanted to act as a control.

Root diseases caused by *Fomes lignosus* and *Ganoderma pseudo-ferreum* have occurred in the rubber, a total of 220 trees being affected. A root disease census of the block has been taken by the Pathological Division, and information regarding the incidence of root disease in the ravine plots is being prepared.

In the coffee area considerable leaf disease has been noticed and a mould disease of the berries has started to show up lately. Spraying with lead arsenate solution has been carried out.

ROADS AND BRIDGES

The roads over the Station have been upkept by weeding and trimming the sides monthly at a cost of 5 cents per chain. Light metalling and sanding was carried out where necessary. The hill road continues to stand up well.

Narrow, reinforced concrete bridges made on the Station were fixed over drains where necessary. Inspection paths through the cover crops were cut where necessary.

DRAINAGE

A main outlet drain from north to south was cut through the unstumped area in Block 14, and a system of herring-bone drains to this main tap are to be put in.

The existing system of field and anti-malarial drains was upkept.

Turfing the sides of the drains to a height of 18 inches from the bottom has proved effective and little under-cutting or slipping has occurred.

TERRACING, SILT PITTING AND BUNDING

The grasses and other covers having grown well over the hill area it has only been necessary to carry out minor repairs, after heavy rainstorms.

No repairs have been necessary to bunds in Blocks 15, 19 and 23 as the cover planted on these when constructed, has held them up satisfactorily.

COVER PLANTS

The common leguminous cover plants have made satisfactory growth, but where they are not turned into the soil by cultivation they appear to have a definite retarding effect on the growth of the rubber trees. This is most noticeable in areas planted with the low creeping covers particularly *Centrosema pubescens*.

Indigofera endecaphylla has made excellent growth in all young areas, confirming the view expressed in the previous report that, for soils of a light sandy type in open situations, this plant is one of the best and quickest growing of the leguminous ground covers.

Crotalaria anagyroides (giant *Crotalaria*) and *Leucaena glauca* (Lamtoro) appear to be the most satisfactory shrub covers. Lamtoro is probably to be preferred as it is better able to resist storm damage than the weaker plants of *Crotalaria*.

Considerable sales of seed of both these covers and of *Indigofera* cuttings have been made during the past year.

Seeds of the indigenous shrub *Fagraea racemosa* have been obtained and planted, but germination is slow.

"FORESTRY METHOD" OF PLANTING

The so-called "forestry" methods of cultivation, more correctly the cultivation of rubber in association with an under-growth of indigenous plants, have attracted a great deal of attention from visitors to the Station.

Block 11.—In this experimental block of 10 acres, planted in early 1929, rubber is being grown with an undergrowth of "natural" covers the growth of which is controlled in various ways. Com-

parison is made with a neighbouring block planted at the same time by the normal method and maintained under either leguminous covers or clean weeded.

In the experimental block, comparison can be made between the following treatments:—

- A. Minimum control of natural growths. All secondary jungle plants are allowed to grow, and only those which appear likely to outstrip the rubber trees in rate of growth, i.e. soft-wood trees, are occasionally pollarded.
- B. Control of natural covers by slashing to a height of 3 feet at intervals of 6 months combined with the selective weeding of plant species considered to be undesirable, e.g. bracken and "Straits rhododendron".
- C. The removal of the indigenous growths in A and B. (For this purpose a strip of $2\frac{1}{4}$ acres, including equal areas of A and B, was thoroughly cleaned in February).

Two densities of planting are represented, square planting at 22ft. $\times$ 22ft. and avenue planting at 22ft. $\times$ 11ft.

During the first two years the rubber trees throughout this block shewed better growth than those in the control area (Block 9). Subsequently, growth measurements have shown a pronounced retardation of growth in the experimental block. The effect of clearing (treatment C above) has been to stimulate growth in a very striking manner.

In the area controlled by periodic slashing, many of the plant species have been killed out and the dominant plant in the undergrowth at present is the common, creeping fern *Nephrolepis biserrata*.

The incidence of root diseases in the plots under "natural" cover plants has been remarkably small so far and considerably less than in the control area.

SOIL WASH EXPERIMENT WITH BUSH AND LOW COVERS

Block 19 (3.6 acres).—In this block, on which measuring posts were placed in and between the terraces, soil movement is recorded by the Soils Division.

The *Vigna* in the plot under this cover is now practically non-existent, this cover having died off after two years. *Pueraria javanica* still continues to be the best of the low covers in reducing soil erosion.

CULTIVATION

Blocks 17, 19 and 24—The practice of digging in grasses etc., alternate-monthly, in a circle round the plants was discontinued. The work is now done six-monthly and only young trees and supplies are so treated.

In Block 19 an area of 9 acres is specially treated. 3 acres under grass are kept as a control; in another 3 acres, the grass is dug in every 6 months and 3 acres is kept clean weeded. The clean weeded area shows the best growth at the present time.

On several of the young areas under the control of the Botanical Division it was noticed that the heavy growth of cover was retarding the young plants. It was therefore decided to pull back the covers to a distance of 8 feet from the plants and to treat the circles by hand weeding and light forking in alternate months. In all, a total of 250 acres comprising Blocks 2, 5, 14, 16, 18, 20, 21, 22 and 25.

In Block 3, which had a good growth of *Centrosema pubescens*, the cover was dug in except on the bunds and the area is now to be kept clean weeded.

PESTS AND DISEASES

Grasshoppers still continue to cause trouble and many young shoots of buddings are found to have been eaten by these pests. Bamboo shields and wire guards are an assistance against their attacks. Termites are beginning to show up in the blocks under timber and in the "Forestry" block (No. 11).

Various treatments such as dusting with Paris Green, Cyanomag, calcium arsenate, Dutox and sodium silicofluoride are in hand and results are being recorded by the Pathological Division.

Experimental treatment for the control of root disease has been carried out throughout most of the planted area, the method of treatment being the same as reported last year. This work is directed by the Pathological Division, the scheme of treatment employed being specially adapted to the needs of the Experiment Station.

Pink disease (*Corticium salmonicolor*) continues to be sporadic and treatment with asphaltum-kerosene and 20 per cent solution of Brunolinum is carried out.

Considerable damage by lightning has occurred in one part of the "density planting" experiment (Block 14 East), 70 trees being affected.

No *Oidium Heveae* leaf disease has been seen on the Station. Considerable defoliation by a red spider was noticed and specimens

of the spider and attacked leaves and flowers were sent to the Pathological Division for examination.

RECORDING INSTRUMENTS AND MEASUREMENTS

The soil thermometers and the Stevenson screen and sun dial were taken to the Institute for use in another experiment. The barograph and automatic rain gauge remain at the Station.

Growth measurements are taken periodically in Blocks 5, 6, 7, 8, 10, 11, 16, 17, and 19; the data is returned to the Heads of the Divisions concerned.

ISOLATION PLOTS IN JUNGLE

Plot A (5 acres) contains only buddings of *Hevea spruceana*; Plot B contains buddings of *Hevea spruceana* and seedlings of *Hevea brasiliensis*. The object of these isolation gardens is to obtain seedlings both pure and hybrid of *Hevea spruceana* for experimental work on budding. It is possible that seedlings of *Hevea spruceana* may prove valuable as stocks for budding with *Hevea brasiliensis* under certain conditions.

The trees in these plots are planted at 22 ft x 11 ft and a natural cover of secondary jungle plants is maintained between the rows. This undergrowth is controlled by slashing at intervals of 4 months.

WEEDING

The system of weeding instituted at the end of 1932, worked well. The average cost to October was 22.6 cents per acre for 300 acres.

In October a new type of weeding and forking over the special 250 acres of the Botanical Division area was added and, despite the enhanced area to be weeded, the cost for the whole Station for November and December averaged only 27 cents per acre. Lallang grass control, except in the swampy areas and in the elephant belt, is done by the weeders.

The building site and edges of main outlet drains etc., are slashed monthly.

BUDDING

Budding work has been mainly confined to "supply" budding in the various experimental blocks under the control of the Botanical Division. Additional work on modified methods of budding on large stocks has been carried out and the use of strips of old motor car tyre, in the manner similar to that employed in the Garrot

method in which bamboo slips are used, has proved very successful. On large stocks over 3 years of age, 75 per cent of successes was obtained in a large-scale field experiment. The method is economical, the cost of materials per budding being 0.3 cent compared with 2.3 cents by the waxed-bandage method.

Block 15 (83 acres).—The budding of new clones from selected mother trees chosen on estates in all parts of Malaya has been completed. The growth of the majority of these new clones is excellent.

Block 20 (22 acres).—An experiment in the duo-clone system of planting of buddings has been established. Sixteen clones, including the Lampongiana and Waringiana clones from Java, have been used in this experiment.

Further experimental work on snag treatment and the use of wound dressings on buddings has been completed.

MEDICAL; HEALTH; WATER SUPPLY

Health conditions have been good. The following cases were admitted to hospital:—

Fever	Maternity	Wounds etc	Total
2	7	12	21

Brush-oiling over the whole opened area was continued and the Visiting Medical Officers are satisfied that the method is working well.

The total amount spent on oil and labour by this method for the year was \$225/57, as compared with \$1424/59 in 1931 by the spraying method. The rainfall for the two years was 97 inches in 1931 and 112.17 inches in 1933.

Drs. Macaskill and Cameron continued to act as medical advisers for the year, and I would like to take this opportunity of thanking them for their advice and help.

The pipe line from the dam in the jungle to the Station continues to function satisfactorily.

RAINFALL

The rainfall for the year was 112.17 inches. The heaviest rainfall experienced was 7 inches in 24 hours on the 7th April.

BUILDINGS AND MACHINERY

All buildings are in a good state of repair. Monthly inspections for ravages by white ants and other pests are carried out.

The engines for the electrical installation are in good order and have functioned successfully during the year.

Electrical storms have caused some damage. One voltmeter and several registering meters in the bungalows have been damaged.

STAFF

The staff has been as follows:—

Manager

Clerk

Field Conductor.

Two Laboratory Assistants from the Institute are attached to the Station for experimental work on budgrafting and pests and diseases.

CORRESPONDENCE

There has been considerable correspondence during the year with regard to cover plants, their habits and methods of establishment. A number of enquiries regarding costs for deep digging etc., have been dealt with.

COST CARDS

Cost cards of all work done on the Station are kept for the use of visitors. These have proved of interest as many questions have had to be answered regarding them.

GENERAL

135 visitors have been taken round the Station.

The Vice-Principal of the School of Agriculture, Serdang and a party of students visited the Station.

For the benefit of those who may wish to visit the Station it may be mentioned that there is a Rest House, and also a Hostel for accommodating conductors and penghulus.

I wish to take this opportunity of thanking Mr. D. S. Gardner, (Visiting Agent) and the Research Officers collaborating in the work of the Station for their help and advice.

The work of the Asiatic Staff on the Station is noted with appreciation.

H. W. FOSTON

Manager

ANNUAL REPORT

LIBRARY

BOOKS AND PERIODICALS

25 new books and 77 periodicals were purchased during the year; 240 miscellaneous bulletins, circulars and pamphlets were received; 235 books were bound.

EXCHANGES

145 Institutions and official bodies continued to send their publications in exchange for those published by the Institute.

DISTRIBUTION OF PUBLICATIONS

2578 copies of each publication issued by the Institute were distributed free of charge to Rubber Plantations, Companies, Corporations, Institutions and individuals whose names appear on the Institute free mailing list, as follows.—

Estates	...	...	...	...	1944
Agency Houses, Institutions, individuals etc.	...				358
Foreign free list: Manufacturing firms					
individuals etc.	...	...	...	...	276
				Total	2578

The decrease of distribution to estates in Malaya, as compared with 1932 when 1985 copies were issued, is due to the closing down of estates, mostly small holdings, and to the fact that some European estates were amalgamated or put under one management instead of two or three as heretofore.

There were 126 subscribers as against 190 in 1932, shewing a decrease of 64.

The total issue was therefore 2704 copies as against 2746, the distribution to Institutions, (exchanges), individuals, manufacturing firms etc., having been increased by 73 copies.

PUBLICATIONS

The following publications were issued during the year:—

Annual Report 1932
 Planting Manual No. 5
 Index to Journal Vol. 4
 Journal. Vol. 5, No. 1

Additions to Planting Manual No. 5 were prepared towards the end of the year and were in the printers' hands in December. These will be distributed early in 1934.

As only one number of the Journal (Vol. 5, No. 1) was published in 1933, the numbers to follow in 1934 will be in continuation of this volume. Volume 5 will therefore cover the years 1933 and 1934.

As a result of the increasing demand for information on the various phases of budgrafting of *Hevea brasiliensis*, which has until now been rather scattered, a bibliography from the publications received at the Institute has been compiled.

INDEXING

The indexing of articles of interest in various publications was maintained. 1550 cards were typed and added to the index.

The card system introduced in 1932 for the purpose of keeping a record of books and periodicals on loan proved very helpful for tracing books borrowed.

31 books were borrowed by planters and planting companies. As only 8 were loaned outside the Institute in 1932, this can be taken as an indication of the greater interest taken by planters in the scientific literature on rubber.

TRANSLATIONS

A number of translations were made mostly from French, Dutch and German publications.

ANALYSIS OF CORRESPONDENCE

395 letters were received by the Library, most of them asking for information and publications concerning methods of cultivation and factory procedure. Some of these letters were referred to the Divisions concerned and 168 were despatched by the Library. These do not include circular letters and acknowledgement slips.

A. McINERNY

Librarian

ANNUAL REPORT

LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

The Committee and Technical Sub-Committee each held four meetings during the year.

The Committee regret to report the death in January 1933 of Mr. W. A. Williams, a member of the Technical Sub-Committee, who had been associated with the London Advisory Committee of the Ceylon Rubber Research Scheme since its inception in 1915.

The Research Association of British Rubber Manufacturers determined their nomination of Mr. F. G. Ascoli as a representative of rubber manufacturers on his ceasing to be a member of the Board of Management of the Association, and the Committee decided to take no action regarding the filling of the vacancy for the time being.

Dr. W. A. Youngman, the Chairman of the Board of Management of the Ceylon Rubber Research Scheme, attended two meetings and also visited the laboratories. The Committee are glad to observe from his report to the Board of Management on returning to Ceylon that he was favourably impressed with the value of the work in London and the assistance rendered by the Committee.

Meetings of the Technical Sub-Committee were attended by Mr. R. O. Bishop and Mr. J. D. Hastings of the Chemical Division of the Rubber Research Institute, Malaya. These officers also worked for a short period in the London laboratories during their leave in England in order to obtain first-hand knowledge of the methods of testing adopted and the problems under investigation. Series of visits to factories and to representatives of different sections of the rubber trade were arranged with a view to placing them in touch with recent developments in the industry and in consumers' requirements likely to be of value in connection with the work of the Rubber Research Institute. The conferences held in 1932 with the Director of the Institute and the personal discussions with those officers have undoubtedly been of the utmost benefit in effecting improved liaison between the work in London and in the East, and have led to a fuller appreciation and much greater utilisation by the Rubber Research Institute of the services which can be rendered by the London Advisory Committee and its staff.

A considerable portion of Mr. Bishop's time was devoted to a study, in conjunction with the London staff, of the marketing and possible developments in the use of rubber latex. During the course of these enquiries it became evident that, in view of the importance of the American market, a complete review of the position could not be made without personal discussion with consumers in the United States of America and, in view of the time which would be involved in obtaining authority from the Rubber Research Institute for the expenditure consequent upon Mr. Bishop's return to Malaya via the United States, arrangements were made with the Technical Research and New Uses Committee of the Rubber Growers' Association to bear the cost of this visit. The Committee are of the opinion that the information obtained by Mr. Bishop in America should be of considerable value in connection with the technical research carried out on behalf of the planting industry and they hope that means may be found for maintaining regular personal contact with American consumers.

A copy of the report of the Commission of Enquiry into the affairs of the Rubber Research Institute of Malaya was received from the Secretary of State for the Colonies with an invitation to submit observations. The Committee had the advantage of discussing the report with the Chairman of the Commission, Professor F. L. Engledow and receiving from him detailed explanations of the recommendations. A communication was forwarded to the Secretary of State expressing approval of the report and suggesting that effect should be given to the recommendations as soon as possible.

At the request of the Institution of the Rubber Industry a meeting of the London Section was held at the Imperial Institute on the 27th November, 1933, in order that members connected with the sales side of the industry should obtain a first-hand acquaintanceship with the work on rubber being carried out on behalf of the rubber research schemes of Ceylon and Malaya. Nearly 200 attended this meeting which proved to be of considerable interest not only to the sales section but to many technical members of the Institution. It received very favourable notice in the technical press and a number of useful new personal contacts were established with various manufacturing interests. After an inspection of the exhibits in the Ceylon and Malaya courts of the Imperial Institute Galleries, especially those dealing with rubber growing and preparation, two popular films showing the production of rubber were displayed. Three short papers of a non-technical character were then read by the staff, after which visits were made to the rubber laboratories where the research in progress was

explained and demonstrations given of the methods of testing employed.

At the request of the Board of Management of the Ceylon Rubber Research Scheme advertisements were issued in various journals for an assistant chemist for research in Ceylon on the preparation and utilisation of raw rubber. The candidate provisionally selected by the Board of Management (Mr. M. W. Philpott, B.Sc.) was interviewed by the Committee and their suggestion that, in view of his previous experience, he should be offered a higher initial salary than that advertised was adopted by the Board of Management. Mr. Philpott will work in the London laboratories for a short period before sailing in April, 1934, to take up the post in Ceylon.

FINANCE

The expenditure incurred in connection with the work in London during the year amounted to £2882.15.1. After allowing for liabilities outstanding at 31st December, 1933, there was an unexpended balance in London of £350 and there was also a balance of £34.16.6 held on behalf of the Rubber Research Institute of Malaya from the funds supplied by them to meet expenditure incurred on behalf of the Institute.

CO-OPERATION WITH OTHER ORGANISATIONS

Mr. G. Martin continued to serve as a representative of the Research Association of British Rubber Manufacturers on the joint committee of that Association and the British Electrical Research Association dealing with the quality of ebonite. A study is being made by the Joint Committee of the effect of different types of raw rubber and special sets of samples with low moisture absorption were asked for from Malaya with a view to determining the possibility of producing ebonite with improved dielectric properties. Assistance was rendered by the London Committee in the preparation of the Handbook of Physical Constants which the Research Association is undertaking on behalf of the Rubber Growers' Association.

During the year contact was made with the India Rubber Manufacturers' Association. A conference was held with representatives of their Technical Committee to discuss representations made by the Association as to the possible effect on raw rubber of the use of certain chemicals on estates. As a result of arrangements made at this Conference a detailed investigation of the subject was undertaken in conjunction with the staffs in Ceylon and Malaya.

The special grant from the Technical Research and New Uses Committee of the Rubber Growers' Association for the development of applications of unvulcanised rubber crumb was continued and work on the subject is still in progress. A report was supplied to the Rubber Growers' Association towards the end of the year containing a detailed account of the investigations, and copies of this report were forwarded to the Rubber Research Scheme, Ceylon, and the Rubber Research Institute, Malaya.

In conjunction with the Rubber Producers' Research Association steps were taken to obtain English patents for the processes for the preparation of crumb rubber and other inventions arising out of the work of the staff in London.

Applications granted:—

- 395774—A new and improved process for the preparation of soft rubber
- 395775—Process for the preparation of unvulcanised india-rubber in crumb or powder form
- 396880—Improvements in and relating to the manufacture of unvulcanised india-rubber from rubber latex

Applications filed:—

- 34181/32—Process for the preparation of unvulcanised india-rubber in granular form
- 20653/33—Improvements in and relating to the manufacture of rubber
- 35277/33—Improvements in and relating to the manufacture of rubber.
- 835/34—Improvements in and relating to the preparation of rubber and road-tar mixtures.
- 4224/34—Improvements in and relating to the concentration of latex

Authority was given to the rubber research organisations in Ceylon and Malaya to import the above inventions if they so desire.

Investigations.

Particulars of the investigations completed and in progress during the year are given in the appendix. The following reports were forwarded to Ceylon and Malaya:—

1. The Technical Advantages of Reclaim and their bearing on the Preparation of Rubber.—Popular summary of paper dealing

with detailed investigations of several types of reclaim in the Committee's laboratories—read by Mr. Martin before the Institution of the Rubber Industry (London Section) March, 1933.—(Published in the Bulletin of the Rubber Growers' Association, May 1933).

2. Clone Rubber from Ceylon—12 samples from Hillcroft Clones 28 and 34.

3. Duprene—a synthetic material resembling rubber in some of its characteristics and for which specific advantages are claimed.

4. Hot Water Treatment of Coagulum rolled to Sheet—Samples prepared by Mr. O'Brien with a view to comparing the effect of this treatment on crepe and sheet.

5. Rubber packed in bales and dusted with powder. (From The Rubber Research Institute, Malaya).

6. "Softened" Rubber—prepared by the Ungar and Schidrowitz process.

7. The effect of adding Plastogen to latex on the plasticity of rubber—Samples received from the Rubber Research Institute, Malaya.

8. Sheet rubber containing different amounts of bitumen—forwarded by the Rubber Research Institute, Malaya, in connection with experiments with a view to obtaining a material as "dead" as reclaim.

9. Effect of storage on the properties of rubber—series of samples prepared by the Department of Agriculture, Federated Malay States, in 1916—1917.

10. Soft air-dried sheet prepared by the Rubber Research Institute, Malaya, by the coagulation with papain of skim from centrifuged latex.

11. Crepe prepared in Malaya by heating latex in an autoclave—forwarded for determination by its suitability for manufacturing purposes particularly as regards ease of manipulation.

12. Suitability of wooden barrels as containers for field latex (from the Rubber Research Institute of Malaya).

13. Examination of latex concentrated by creaming—reports at intervals throughout the year, (from the Rubber Research Institute of Malaya).

Reports on Items 7, 8 and 11 will be published in the second number of the Rubber Research Institute Journal during 1934. In relation to Item (5) further consignments have been despatched and a report will be published later in the Journal of the Rubber Research Institute of Malaya. Investigations in relation to Item (10) are being continued and a report will be published later.

A report is awaited from the United States of America on the shipment of latex in wooden barrels (Item 12). A report on this method of shipment will be published later.

The rubber research organisations in Ceylon and Malaya were also kept fully informed of important latex developments.

P. J. BURGESS

Chairman

J. A. NELSON

Secretary

Imperial Institute

London, S.W. 7

29th March, 1934

APPENDIX TO REPORT OF LONDON ADVISORY COMMITTEE, 1933

LATEX

In view of the important developments which are rapidly taking place in the use of rubber latex, considerably more attention than in previous years was devoted to problems relating to methods of concentrating and testing latex.

The first of the experiments on concentration was carried out by modification of a well-known method at the request of the Rubber Research Institute of Malaya, and in personal co-operation with Mr. Bishop during his leave in this country. Satisfactory results were obtained and arrangements have now been made to continue the work on a larger scale.

During these experiments it became obvious that some commercial consignments of latex (38 to 40 per cent. dry rubber content) of poor quality were arriving in this country and that recognised methods should be prescribed for determining quality in order to avoid prejudicing developments of new uses of latex, outside the rubber manufacturing industry by preliminary trials with unsatisfactory material. About the same time particulars were received from the Rubber Growers' Association of proposals for a quality specification which had been submitted to the Association. A special study of the subject was accordingly commenced and up to the present the work has been concentrated on tests on the following properties:—(a) strength of dry films, (b) stability and (c) viscosity. The film strength test is strongly recommended by a large firm interested in latex as a result of their practical experience, but experiments in the Committee's laboratories showed that the results given by this test are markedly affected by a number of factors which require accurate control in order to obtain reliable figures. A stability test based on information received from various sources has been developed and is now used for the routine testing of samples of latex. A satisfactory method of measuring the viscosity of latex has not yet been evolved, but a number of promising methods are being explored. A quality specification for latex is very desirable, but more experience with testing methods is necessary before making definite recommendations and the matter is still under consideration.

A number of new contacts were made with latex consumers in Great Britain during the year, in the course of which attention was called to the demand for a type of "concentrated latex" not on

the market. Experiments were carried out in the London laboratories, where a method was developed with a view to obtaining a suitable product. Satisfactory reports were received on small samples submitted to various consumers, and material for works trials is now being prepared. Suggestions have also been made for experiments in the rubber research laboratories in Ceylon and Malaya.

It was shown by the Rubber Research Institute that gum tragacanth varies considerably in its power to cream latex. Nearly thirty samples representing a wide range of commercial grades, were therefore obtained from dealers in London and tested as to their ability to cream ammonia-preserved latex. Approximately one-third of the samples, including several of the cheaper grades, proved to be excellent creamers and one-third definitely poor creamers. The good creamers formed viscous solutions but there was no definite relation between creaming power and viscosity or between creaming power and mineral constituents. Tests on a further consignment confirmed that some of the cheaper grades were excellent creamers and samples of these were therefore despatched to Malaya for further examination by the Rubber Research Institute.

Series of samples of latex concentrated by modifications of creaming methods received from the Rubber Research Institute were examined in the London laboratories and submitted to consumers for works' trials. Some of the samples were satisfactory and the methods could be recommended if the patent position were clear.

A sample of 38 to 40 per cent. latex preserved with ammonia at the Rubber Research Institute was shipped in a 40-gallon wooden cask made from local material. An appreciable amount of evaporation occurred during transit, but this method of shipment is of particular interest because of the excellent colour of the latex, presumably due to the absence of contact with a metal container.

TYPES OF RUBBER REQUIRED BY MANUFACTURERS

(a) *Soft Rubber.* Progress was made in a number of directions in the study of methods of preparation of types of rubber to suit the requirements of manufacturers for definite purposes; and special attention was paid to the production of soft, easily-manipulated rubber for which there should be a large demand if a satisfactory product can be obtained.

The examination of the "softened" rubber prepared by the oxidation of coarsely disintegrated rubber (Ungar and Schidrowitz process) and referred to in the last annual report was completed. The rubber was softer and more easily manipulated without

preliminary treatment than estate crepe and sheet submitted to the usual masticating process. Its mechanical and ageing properties after vulcanisation in a rubber-sulphur mixing were rather poor, but in a number of technical mixings excellent results were obtained, and for some purposes the rubber appears to have good commercial prospects, if offered at a suitable price.

As rubber is frequently softened by manufacturers by mixing with well-known softeners during milling, it seemed possible that a satisfactory soft rubber could be prepared by adding emulsified softeners to latex. Although a wide range of both popular and little used softeners was tried in experiments in London using ammonia-preserved latex, the effect on the manipulative properties of the dry rubber was much milder than in the oxidation treatment employed in the Ungar and Schidrowitz process, and there appeared to be no advantage in adding the softeners to the latex over the present practice of mixing them with crepe or sheet during manufacturing operations. The feasibility of adding softeners to latex followed by oxidation of the dry rubber was then considered, but it was found that the softeners frequently retarded oxidation and it was not possible to produce a very soft rubber without heating it in air to an extent not materially different from that employed in the absence of softeners.

Other modifications of the oxidation method of softening rubber gave more promising results. The experience gained enabled suggestions to be made for further work in the East with fresh latex.

Experiments were also made on the use of rubber as a softener, after heating for some time at about 240°C. The softening effect of the molten rubber on crepe and sheet was not so marked as expected, but the molten rubber could be easily emulsified in the presence of ammonium stearate and ammoniacal casein to form a type of artificial latex which could be mixed with natural latex. The rubber obtained by mixing the latices was softer than usual but a considerable amount of molten rubber latex would have to be added to obtain a product as soft as the oxidised rubber prepared by the Ungar and Schidrowitz process.

It was also found that compounding ingredients could be easily mixed with molten rubber by stirring and that, after vulcanisation, products with a fair strength were obtained. This process may have commercial applications but it involves the development of a new technique to which so far it has not been possible to devote attention.

A number of samples of soft rubber prepared by the addition of emulsified softeners to latex were received from the Rubber Research Institute of Malaya for examination, but as in the case of

the above investigation of samples prepared in London from preserved latex, the materials were not sufficiently soft to be of definite commercial interest. Rubber prepared by coagulating latex by heating it at about 150°C in an autoclave was more promising but the rubber was by no means as soft as the oxidised rubber already on the market and the Rubber Research Institute of Malaya stated that the method of preparation was not without difficulty.

A soft rubber prepared at the Rubber Research Institute of Malaya by a novel method was not so soft as oxidised rubber. The physical and mechanical properties after vulcanisation were satisfactory but the ageing properties were inferior to those of ordinary sheet or crepe. The study of this method is being continued.

Reference was made in previous reports to the preparation of soft rubber by a chemical treatment of latex which did not involve oxidation. The method consists in the addition of a little sodium nitrite to latex prior to coagulation, and has since been described in E.P. 3197. In view of the interest of certain manufacturers a small consignment was prepared by the Rubber Research Scheme, Ceylon, for technical trials. The reports indicated that there is little hope of using this type of rubber for general manufacturing purposes. It has however unique properties and may be of value outside the rubber manufacturing industry. In subsequent experiments in London a greatly improved product was obtained by a modification of this method and particulars of the process were forwarded to the rubber research organisations in the East for investigation with fresh latex.

Attempts to prepare soft rubber by treating latex with a solution of hypochlorite were made by the Rubber Research Institute, Malaya, but the examination of the samples in London showed that the effect of the hypochlorite was too small to be of commercial value. The possibility of obtaining improved results by a modification of the method was suggested by the Technical Sub-Committee.

(b) *Water absorption.* Co-operation was again maintained with the Research Association of British Rubber Manufacturers and the Electrical Research Association in their joint investigation of the quality of ebonite in connection with which the preparation of rubber with low moisture absorption may play a prominent part.

The study of the water absorption properties of a comprehensive range of estate crepe and sheet from Ceylon which was completed during the year showed that some of the samples absorbed four times as much water as others. This emphasized

the importance of carrying out the tests previously suggested on the quality of ebonite. Arrangements were accordingly made for experiments to be carried out in the East with a view to the preparation of suitable material for technical trials.

Rubber prepared from very dilute latex which was received from the Rubber Research Institute, Malaya, was found to offer little advantage as regards water absorption, but it is understood that other methods of preparation which are under investigation by the Rubber Research Institute are proving to be more satisfactory.

(c) *Sulphuric Acid*. Economic conditions in the plantation industry have led to the use on some estates of sulphuric in place of formic or acetic acid as a coagulant of latex and the India Rubber Manufacturers' Association expressed their concern to the Committee at the possibility of the extended use of this chemical. After consultation with the Association, arrangements were made for samples to be obtained from Malaya so that the effect of the use of sulphuric acid might be studied. Investigation of these samples in the Committee's laboratories and the report on a duplicate set which was furnished by the India Rubber Manufacturers' Association showed that, when sulphuric acid was used in the correct proportions it had no harmful effect upon the rubber, but that it would be necessary for manufacturers to make small adjustments of vulcanising periods. At the close of the year the Committee were in communication with the Rubber Research Institute as to the recommendation to be made to estates with regard to the use of this coagulant.

(d) *Paranitrophenol*. The India Rubber Manufacturers' Association also drew attention to the fact that the use of paranitrophenol in crepe preparation caused rubber articles made therefrom to stain the package in which they were wrapped. On making enquiries in the East it was found that paranitrophenol was not being employed for crepe preparation in Malaya and was only in use on one estate in Ceylon where it was definitely helpful in producing rubber of satisfactory appearance. Tests carried out in the London laboratories and on behalf of the India Rubber Manufacturers' Association with rubber from this estate showed that articles manufactured from it were liable to stain paper in which they were wrapped when kept in a damp atmosphere.

(e) *Hot water Treatment of Coagulum*. Previous experiments in Ceylon have shown that in some cases the colour of crepe is improved by immersion of the creped coagulum for a short period in hot water and tests in London have shown that the rubber is of satisfactory quality and somewhat softer than average Ceylon

crepe. As occasional samples of estate crepe are extremely hard and difficult to manipulate by manufacturers it appeared likely that the water treatment would overcome this difficulty, but extensive experience over a long period would be necessary to prove that the rubber possessed this advantage.

Before attempting preparation on a more extensive scale it appeared desirable to obtain the views of manufacturers on the properties of crepe which had received the hot water treatment and a consignment prepared in Ceylon was submitted to four different manufacturers who reported that the rubber was satisfactory. In view of these reports the Committee are of opinion that the method could be safely employed on a more extensive scale.

It is not likely that the rubber would command a premium and therefore the method of preparation is not suitable for general adoption if it involves an increase in cost over the standard method. On the other hand, if the method were more widely adopted and the rubber had the advantage as regards manipulation already suggested, a special demand might arise when the merits of the rubber became fully established.

A series of samples was also received from Ceylon in which sheet coagulum was submitted to the same treatment. but it was found to offer no advantages. The treatment may however be more useful for air-dried sheet than for smoked sheet and it is hoped to test this point at a later date.

OLD RUBBER

Little information is available as to the effect of storage on the intrinsic properties of rubber although in some cases it may be necessary to store rubber for considerable periods. It was found in vulcanisation tests of the Committee on samples which had been kept at a London wharf from three to fourteen years that there was a gradual deterioration in ageing properties in a rubber-sulphur mixing, but as full information regarding the origin of the samples was not available it was considered undesirable to publish the results. A series of crepe samples prepared by Eaton and Grantham at the Department of Agriculture, Malaya, in 1916—1917 was subsequently received. Tests on these samples indicated that rubber in crepe form deteriorates slowly on keeping in the tropics; this deterioration is characterised by a gradual softening of the rubber and the development of poor ageing properties after vulcanisation in a rubber-sulphur mixing. Although this deterioration would not be marked in the technical mixings largely used by manufacturers it appears desirable to use rubber as soon as possible after preparation.

CLONE RUBBER

Information concerning the properties of rubber from different clones is gradually being extended as material for test becomes available. During the year samples were received from two Ceylon clones on which tapping had commenced. The trees were too young to draw satisfactory conclusions as to the quality of the rubber but the results obtained will be useful for comparison with those given by rubber from other clones of a similar age and rubber from the same clone when the trees are more mature. As more trees and other clones come into tapping in the East a considerable amount of time will have to be devoted in London to the examination of clonal rubber.

DUPRENE

Since the beginning of the present century there have been several attempts to produce synthetic rubber on a commercial scale, but in all cases the material proved inferior in quality to natural rubber from *Hevea brasiliensis*. A novel synthetic product has obtained prominence recently, marketed under the name of Duprene, because of the advantages claimed for it over plantation rubber as regards resistance to oil absorption, moisture absorption, gas diffusion, heat and sun cracking.

These claims were generally confirmed in tests in the Committee's laboratories, but the mechanical properties of Duprene were not equal to those of rubber in the mixings employed, and the "vulcanised" Duprene became extremely hard on keeping for a few weeks. Duprene is a new material which it is understood is being sold at \$1.00 (gold) per lb. in America and the present output is about 10 tons per month. It is however reasonable to expect that further research will result in reduced cost and an improved product, but even then it is unlikely that it will replace plantation rubber for most manufacturing purposes. Duprene undoubtedly has advantages for special purposes but its price is high and further research may improve rubber products so as to make them equal to or better than Duprene in the directions in which at present it shows some advantages.

PACKING

In connection with the enquiry carried out in 1932 with the help of the Research Association of British Rubber Manufacturers as to the types of rubber required by manufacturers, a suggestion was received that rubber should be dusted with a surface lubricant before packing in order to facilitate separation of the sheets in this country. At the request of the Committee the Rubber

Research Institute of Malaya, prepared samples dusted with surface lubricants and baled in different materials, as it was desired to ascertain whether the massing which is usually experienced with bales would be avoided by dusting. Dusting prevented the massing of the rubber somewhat but its effect was not sufficient to enable the sheets to be pulled apart as easily as most rubber packed in cases which is also difficult to separate and frequently causes trouble to the wharves and the smaller manufactures who have no machinery for handling large blocks of rubber. It is therefore proposed to carry out further experiments to determine whether any improvement will be effected by dusting rubber packed in cases.

RUBBER CRUMB

In the report for 1932 an account was given of two methods of preparing rubber in crumb form devised by the staff in London, and of the factors likely to limit its use in the rubber industry unless it can be offered at a price similar to that of crepe or sheet. As the cost of preparation and shipment will not render it remunerative to offer supplies at the price of standard grades of plantation rubber, attention was devoted during the year to the possibility of finding a use for the material outside the rubber industry, particularly for road surfacing. The results of a comprehensive series of laboratory tests carried out in association with an important firm of manufacturers indicated that in certain circumstances the crumb confers distinct advantages, but a considerable amount of further laboratory work followed by technical trials will be required before any opinion can be expressed as to whether a process suitable for use on a large scale under ordinary working conditions can be devised.

Recently considerable publicity has been given to two processes invented in Holland for the preparation of raw rubber in the form of crumb. In one process the latex is sprayed on to a moving band from which it is removed mechanically in the form of crumb; this material consists of whole rubber together with a little dusting powder and could be utilised for most manufacturing purposes. In the other process latex containing 30 per cent. dextrine (calculated on the dry rubber) is dried by spraying in hot air. The presence of this amount of dextrine would probably render the material unsuitable for many purposes in the rubber industry, but it is in the form of a very fine powder and may therefore find an outlet for special purposes for which the coarser forms of crumb would be less suitable. It is claimed for both of the Dutch processes that the products are likely to be in considerable demand, but although both differ in certain respects from the crumb

prepared in the London laboratories, tests carried out from samples received from the inventors indicated that the materials are likely to present similar difficulties in obtaining an extensive outlet in the rubber manufacturing industry unless supplies can be made available to manufacturers at a price similar to that of crepe or sheet. In this event the facility with which rubber crumb can be handled should appeal strongly to manufacturers.

G. MARTIN

Imperial Institute,
South Kensington,
S.W.7

